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The Geographical Journal

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FROM MOSSAMEDES TO THE VICTORIA FALLS

Colonel J. C. B. Statham, C.M.G., C.B.E.

Read at the Meeting of the Society, 5 November 1923.

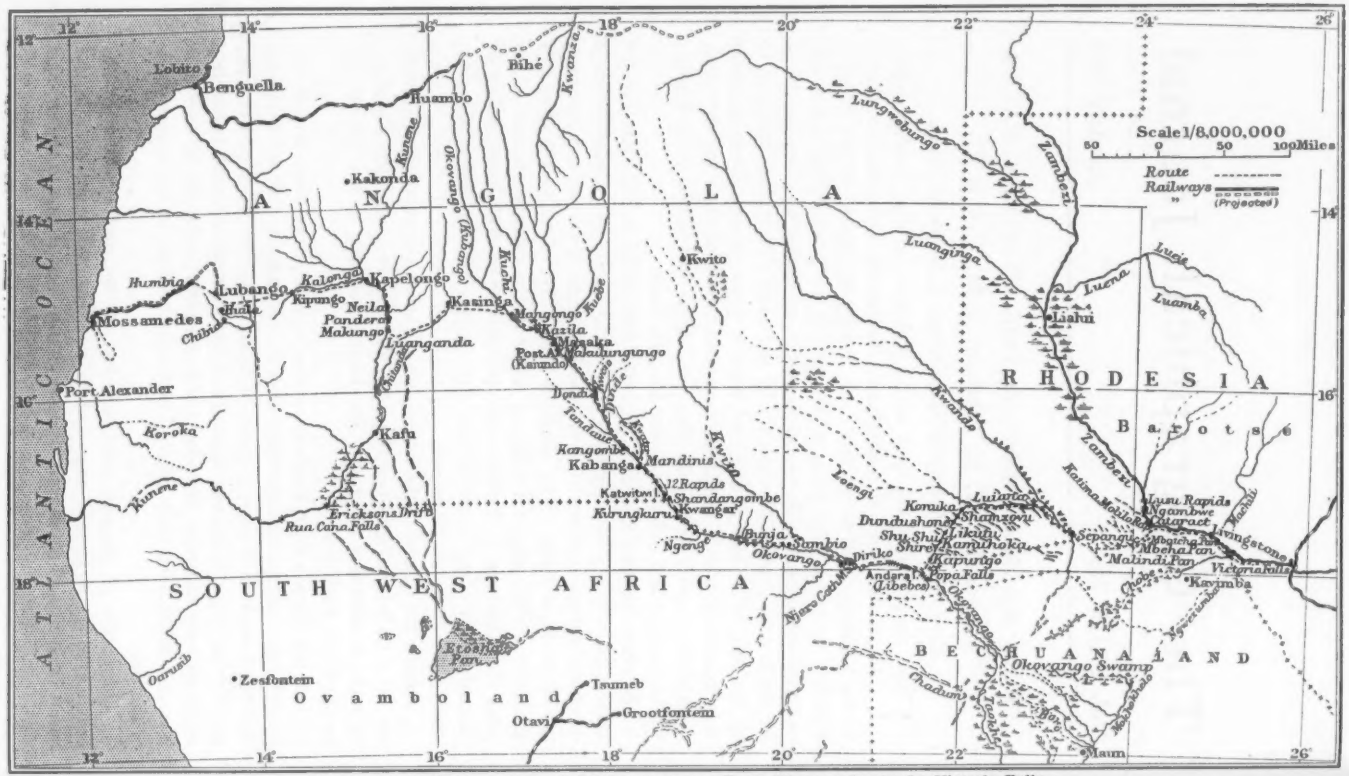
THE route which my wife and I followed on our journey across Africa was from Mossamedes to the middle Kunene river, thence to the Kubango, and along this river, mainly in canoes, for 500 miles to Libebes, near the Popa falls, where, owing to various causes, a north-eastward direction had to be taken across an almost waterless sand-belt to the Loengi river. The practically unknown Loengi was followed to its junction with the Kwando, and when a canoe voyage down the latter was found impossible, the journey was continued through the dry sand-belts in the Caprivi strip to the Zambezi, which we reached at the Katima Molilo rapids, and followed to the Victoria Falls.

As often happens in Africa, the latter part of the actual route differed considerably from that originally intended—which was a canoe voyage down the Zambezi system of rivers, the Kubango, Kwando, and Zambezi, to the Victoria Falls. The obstacles which forced us to abandon this scheme were the reported want of water in the Selinda channel which joins the Kubango to the Kwando, the danger or even impossibility of canoeing down the reed-covered and hippo-infested lower Kwando, and finally an injury I received.

Among the objects of the journey was to study the people and animal-life of little-known south-eastern Angola and the northern Kalahari, to make a collection of plants, and learn something of the nature and possibilities of the country.

Our sea journey from England to Mossamedes, from where we started inland, was very picturesque and varied, including a visit to seventeen African islands and ports: some of them, like San Thome, Principe, and Fernando Po, being very beautiful in their wealth of tropical verdure; while we were fortunate in seeing the Cameroons mountain in eruption, lava and ashes lying deep where I had often roamed in the earlier years of the war.

The coasts of Angola gradually lost its tropical appearance, the beaches, which were arid near Lobito Bay, changed soon after to the desert coast-line which is seen all down South-West Africa to the Orange



Sketch-map to illustrate Colonel Statham's paper: From Mossamedes to the Victoria Falls.

River. The cold Antarctic current which has helped to form the harbour of Loanda and Lobito has probably contributed to the aridity of the region, and is responsible for the heavy mists which shroud this coast and make it cold and damp, when the east coast of Africa in similar latitudes is hot. This mist cost the lives of many passengers and wrecked the steamer *Mossamedes*, on which we had intended to return home from Africa.

We landed at Mossamedes in the middle of May, that is, the cold season. I made a hundred-mile journey by motor car in the desert country south of that town, and between it and Port Alexander, and found the sand-dunes of the coast gradually change to a scrub region with low trees further inland, which in its turn ends at the magnificent scarp of the Shella range which rises from 4000 to 6000 feet above the plain. If in the north and centre of Angola the coastward wall of the highlands lies broken, and the rise to higher plateaux is by terraced hills cut by many a valley, here in the south for mile on mile was a rampart so steep, so rugged, so crowned with granite dome and crag and pillar, as to give the picture of some gigantic fortressed city.

In this desert country there is little human life, the only natives being the primitive Ba Koroka and Ba Kuisso, who appear to have Bushman as well as Bantu blood in their veins. The animal-life has greatly diminished, owing to human persecution, and the plant-life is xerophitic and poor, though including that wonderful plant ***Welwitschia mirabilis***. By day the country is monotonous except in its mirages, but at sunrise and sunset one may see the great wall of the Shellas touched with varied and fast-changing colours.

From Mossamedes we started eastwards by the southernmost of the railways which penetrate Angola. It is the shortest of these lines, and a miniature railway which, crossing the arid coast-belt, climbs up a valley in the Shellas towards Lubango township, 5000 feet up on the southern Angolan plateau, which slopes gradually eastward to the Zambezi, and more rapidly southward to the Kunene and the frontier of S.W. Africa. In this plateau are forests and green glades, streams and waterfalls, and where we stayed at Lubango and in the adjoining townships of Huilla and Chibia, is a white population of 3000 to 4000 Portuguese settlers, and a few Boers.

We had planned to begin our waggon trip at Lubango, but the delay on our sea journey forced us to push on as rapidly as possible, and by good fortune one of the two or three available motor lorries was obtained, and the first 130 miles of the journey as far as Kapelongo on the Kunene was made by that unusual method. On the journey we crossed the Kakoluvar tributary of that river and followed two others, the Sinde and Kalonga, which were but a series of pools in the winter months.

Sketch-map to illustrate Colonel Statham's paper: From Mossamedes to the Victoria Falls.

From the Kunene to the Kubango.

The Kunene at Kapelongo was a deep river some 80 yards across, flowing at 2 or 3 miles an hour, and navigable only in short stretches. We followed this river in a small two-wheeled waggon for some 80 miles southwards, often forcing a way through forest and over bad boulder-strewn ground, when the little waggon drawn by eight oxen was in constant danger of overturning or being smashed. We managed to survive this, and even worse country, when after a week's elephant hunting we left the Kunene at the Makungo rapids, to push our way on through the forest to Kassinga post and towards the Kubango.

The Kunene runs south for some hundreds of miles, and then turns abruptly west. It has been suggested that the river at one time continued south, and formed a river and lake system in Ovamboland, of which the Etosha pan and a few dry watercourses are the remains. The supposed proof of this is the occasional flooding of this region by water coming from spillways in the Kunene, and it is thought that, possibly owing to the silting up of its old southerly channel, the Kunene broke away westwards, or was beheaded by head-stream erosion of the short coastal river which is now the lower Kunene. It is even urged by Dr. Schwarz that a dam placed at a suitable point would divert the water to the old channel and again bring a river and lake system to North Damaraland (Ovamboland), which is now rapidly drying up, but might thus again be rendered fertile. Yet to tap the Kunene, or change its course, would undoubtedly be very difficult, for the forces which could have brought about such a deviation must still be present, even if the old channel could be opened.

The Kunene itself is navigable in certain reaches between Kapelongo and Malundu, where I know it personally; above and below this it is, I understand, practically unnavigable. Below Erickson's drift the cataracts are numerous, culminating in the 300-foot falls at Rua Cana. Below these falls the river has recently been described in the *Journal* by Mr. Maudslay Baynes.

From the Kunene we travelled eastward to a river with the quaint name of "River of the thorn trees," and across it to the Chitanda, a Kunene tributary with alternating stretches of pools and rapids, which we followed till we reached Kasinga post, passing on our way the old gold-workings which have been famous in Angola for centuries, and attracted many a Portuguese expedition into the interior. From Kasinga, where we found a solitary Portuguese official and an abandoned mission station, we continued our waggon journey across the watershed between the Kunene and Kubango, crossing the headwaters of an old river system: the Kuvelai and Kavando river-beds, which once flowed south to the Etosha pan, but are now dry except for a short period in the rains, when they are filled from the sides, and as far as I could learn do not flow as they did less than a hundred years ago. We met the

JUNCTION OF THE KUCHI AND KUBANGO

THE KUNENE RIVER

BA KWATIR WITH MANGONGO FRUIT

BA KWANGAR AND BUSHMAN

BA HUMBE WOMEN ON THE KUNENE

Umbale tributary of the Kubango but a day after leaving the last tributary of the Kunene, the Kalonga, which at one point is only 12 miles from the Umbale.

We saw few people in the region beyond the Kunene, but on this river were a number of villages of various tribes who had crossed it to escape a warrior race called the "Kuanyamas," whose home is near the southern Angolan border, but who carried murderous raids and forays far to north and east, and were a terror in the land till subdued by the Portuguese.

The Kunene women have very curious head-dresses of tresses plastered with various substances, made up with fibre and false hair, and shaped sometimes like a fireman's helmet. They wear a small apron in front and behind, strings of beads and ornaments of brass on their necks, arms, and legs.

The people of the Kunene, like the tribes of the Kubango, are of Bantu stock and very different from the Bushmen of the Kung, Hukwe, and other races met further south; different also from the Ba Koroka and Ba Kuisso, who were met on the west and appear to have Bushman blood in their veins.

The fauna of the middle region was far more plentiful than that on the coast or between it and this river, and must have been unusually numerous before the Boer hunters shot it down. There were elephant, hippopotamus, rhinoceros, buffalo, kudu, roan, wildebeeste, zebra, the black-faced pallah, reedbuck, duiker, oribi, and the usual carnivora. The larger animals are becoming increasingly rare, and buffalo, rhinoceros, and hippopotamus are nearly exterminated on the middle Kunene.

Bird-life is richer and more varied here than near the coast or eastwards on the Kubango, and resembles in its variety of aquatic birds the middle Zambezi valley. Fish and reptiles were equally numerous, especially the crocodiles, which swarmed—one of them nearly ending my existence when filling a canvas water-bag at the river, where he stalked me under water, and then rushed and snapped at my arm.

The watershed between the Kunene and Kubango, the northern portion of which we traversed on our journey, is an undulating country 3000 to 4000 feet above sea-level, covered with open forest interspersed with glades. The trees are mainly *Berlinia Baumii*, but associated with *Copaifera coleosperma* and *Burkea africana*.

Our little waggon fortunately survived the bumps and smashes against the trees and boulders through the forests of the Kunene, or the terribly rough tracks along the Chitanda river, and between Kassinga and the Kubango, and brought us to this river by June 15.

Waggon Journey down the Kubango to Kaiundo. (Posto A.)

Where we met the Kubango, just above Mangongo village, it was a big river, perhaps 80 yards across, even in this the dry season, and flowing deep and clear between low hills and steep banks, clad in flowering

reeds. The river here was navigable in stretches, but 20 miles to the north were the Kakombo cataracts, while we were to meet even greater falls, those of the Makulungungo, before we reached Kaiundu. We followed the right or western bank of the river until we reached this post.

I had crossed the Kubango near its source during my Angolan expedition in 1920, when marching from Bihe towards the then rail-head of the Lobito line, and a day after I had stepped across the headwaters of its greater tributary streams, the Kuchi and Kwito. There these were all rivulets, with just a trickle of water, but that was some 200 miles north of us, and now I was looking at a mighty river, and was to follow its course for hundreds of miles, while the little Kuchi rivulet, met again 50 miles further on, was a deep placid river.

Of the tributaries we passed, the Umbale river does not flow the whole year round, like the Kuchi which we met 60 miles below the Umbale. I canoed up this river for some distance, to find it a deep stream 30 yards wide, flowing through a reed- and grass-grown shallow valley, which is apparently inundated in the rains. The Kubango and some of its tributary rivers flow in curious courses, which look almost unnatural on the map, so straight and parallel are they. In the upper reaches the river valleys are open and grass-grown, affording pasture to great herds of lechwe and roan antelope.

The Kubango, gathering tributary after tributary, passes on within high reed- and tree-fringed banks, sometimes through low valleys, often between stony hills, and over many a score of rapids, to end, after a splendid river career of near 1000 miles, miserably in swamp and sand-belt in the Kalahari. Some think it had at one time a better ending, in the once great Ngami lake. Others believe it earned perhaps greater glory in helping the Zambezi and Kwando to cut that marvellous basalt gorge at the Victoria Falls. Whatever is true, the Kubango's fate is unworthy of the great river we followed for so far and so long.

Among the people of the upper Kubango are the Bihes, a wonderful tribe whose porters travel everywhere in Africa, in whose veins run Bengalla and Jagga blood, and whose very origin was a romance; for the kingdom was founded by the mighty hunter Bihè, who had wandered north from his home in Humbe in search of elephants, and found a northern bride. To the south of the Bihe are the Ganguellas, which may mean either stammerers or People of the East, but does denote a tribe, and not, as many still claim, a country.

The Ambuellas who live to the south of the Ganguellas are as peaceful as the others are warlike, timid as they are savage. These people speak Kimbundu, are a kindly, hospitable folk, and for negroes, hard working. They plant the usual crops of manioc, mealies, messango and macundi, from which they make beer; and even a little cotton, which they weave into a rough cloth. They herd cattle, goats, and sheep, and do a little

ironwork; but some of them, like the Kanguellas of Masaka, make pottery of a clay found in the neighbourhood. The most striking characteristic is the fashion of their hairdressing, for while the men simply shave it in various devices, a circular tuft of hair being left, or a strip from forehead to neck, the women compose a striking head-dress. With them the hair is parted in the middle and formed into two rolls, one on either side, which are united behind: the hair being stiffened and kept in place with fibre, and the crests and edges of the rolls of hair being edged with beads in the most effective way, while they carry many strings of beads round their necks as well. They wear skins, and nowadays cloth aprons, and use bracelets of copper, and even of skin.

Pacific among themselves as well as with their neighbours, the Ambuellas rarely kill or bewitch each other, trial by ordeal seems unknown, and while medicine doctors are respected, wizards are detested and avoided. The villages are usually palisaded, or surrounded with thorn fences. The huts, generally conical, sometimes square, are well roofed, the walls sometimes decorated with patterns. The Ambuellas have quite a taste in furniture, using wooden benches and chairs, and excellent wooden and earthenware pots. Their weapons are spears, bows and arrows, and kerries.

Twice we met Bushmen. Once a little west of the Kubango we found the little men were making gourds in a village, where they had come to earn other food than the flesh and roots which is the usual portion of these wandering and elusive little people. Once more, near Kabanga and again lower down the Kubango, we saw their little encampment of a mat or two under a temporary leaf shelter, where they had stopped to eat a kudu, wounded with a poisoned arrow, and then tracked for miles to where it died and the family camped.

At Masaka we saw the first village since Mangongo, though one or two had been passed unnoticed on the opposite bank. The people of Masaka now lived on the left bank of the river, though but a few years ago they had hidden like wild beasts on an island in its stream. Here only were they and their cattle safe from the marauding Kuanyamas, who had no canoes of their own to reach them, and could not swim the crocodile-infested waters of the deep Kubango. There are plenty of crocodiles still, but very few hippo, which pay endless toll to the native hunters and the rare Portuguese who pass this way.

Our arrival at Kaiundo, where we commenced the canoe journey, was somewhat dramatic, for a troop of lions had been killing a large number of cattle and were said to have killed people as well. An hour after my arrival I managed to kill one lion and wound another, and bring a certain degree of security to the fort, where sentries had been posted on the walls and had been firing every night to keep the lions away. This troop of lions did not worry the post the next ten days of my stay there, and apparently continued their march up river, for it appeared that the

lions had been moving up the Kubango from a long distance south, killing cattle as they went.

Canoe Voyage from Kaiundo down the Kubango to Libebes.

We waited at Kaiundo for ten days to collect carriers for our loads, as there was only one canoe available, 18 feet long by 1 foot 9 inches wide, and cut out of a tree. This dugout was kindly lent us by Lieut. Lacerda for our own use, and it could only carry two or three loads besides my wife, myself, and a couple of paddlers, yet it was by far the best canoe we were able to obtain on the Kubango.

Below Kaiundo the river turned and twisted between high banks and occasional low hills covered with a sandy soil, on which was a growth of small open forest interspersed with grass-grown clearings, here called "shanas." Generally pretty, the river was sometimes unusually picturesque, especially when the clear blue stream ran over rapids and under rugged and high escarpments. We passed half a dozen such places, and quickly realized that our canoe journey was to be arduous and even very adventurous, for in the first four days alone we met nearly thirty islands, rocks, or rapids. The paddlers did not know the river, and there were practically no villages on the banks, so that we had to trust to a rapid reconnaissance and the luck of meeting no submerged rocks, as the canoe rushed towards the channel which, after an anxious glance through binoculars, appeared to give the best chances of safety. The river's width varied from 50 to 80 yards, and the current was sometimes 7 or 8 miles an hour through the narrows and rapids, though only 2 or 3, or even less, through the broads. The depth was from less than 1 foot to 20 feet and more in the deep pools near the rock escarpments. We were travelling, of course, in the dry season, and one that had followed a scanty summer rainfall, so that nothing should prevent a small motor launch navigating the upper reaches of the river in flood-time, for about half the year. Below an island named Dondi, which had once held a village of refugees in the days of the raiding Kuanyamas, we met serious obstacles to our progress, and nearly a dozen rapids in the first three days, besides endless rocks, both submerged and apparent, and a number of islands and sandy shallows. For the next stretch of 40 miles nothing but a small canoe like ours could have found a way without disaster, and even our canoe did not escape, for on three occasions we struck rocks or jammed in the rapids, had to take to the water, and found such difficulty in rescuing the guns and cameras we had in the canoe that a rule was made to carry the latter and all but one of our rifles on land when possible: the least valuable rifle going in the canoe in case of attack by crocodile or hippo. This decision was fortunate, for we just escaped a bad wreck a few days after.

Between the post of Kaiundo and the Kwatiri we had passed two rivers of importance on the left or eastern bank, the Kuebe 10 miles below

Kaiundo, and the Kweio just south of the old post of Dondi; but none on the other. In fact, the country on the right bank of the Kubango provides practically no perennial water to this river, and the murambas or intermittent channels are not numerous. The country to the south-west of this river, and between it and the Kunene, has a river system of its own, which takes water not only from this area, but from both rivers during the rains. These river spillways thus help to form the river-beds called the Kuvelai and Kavandu, which join further south to enter the Etosha pan. From what I saw of the country, and have heard and read, it appears to be slowly drying up, and tending to turn into a desert, which will gradually merge into the adjoining one in S.W. Africa.

The Kubango between Kaiundo and the Kwatiri is navigable for native canoes only in the dry season, for between these points we counted twenty-one rapids, besides many islands, and rocks both submerged and above the water. The rapids were usually shallow, the river running over rocks, small boulders, pebbles, gravel, or even sand, the current varying from 2 to 7 miles an hour, according to the fall and width of the river, which varied from 40 to 100 yards.

The people of the region, and as far as the Kwatiri, appeared to be closely allied to the Ambuellas, if not of that tribe. The land was hilly and between 3000 and 4000 feet above the sea. The rock appeared to be a reddish quartz and sandstone, and the sandy surface soil still continued, but the type of forest had changed; the *Berlinia Baumii* had disappeared, and the principal trees seemed to be the M'Shibi (*Copaifera coleosperma*) and *Baikia plurijuga*, the seeds of which were used by the native for food and oil; another useful tree was the "Mabok" (*Strychnos Schumanniana*) with its big round fruit, while in the grasslands were some ground orchids, like the Eulophia and *Disa equestris*, and where the ground was swampy, *Proteacæ* with pretty white flowers.

The fauna was similar to the Kunene, but lacked the defassa water-buck and wildebeeste, and included the tsessebe and a lechwe, while the impallah, along the Kubango, from Kabango southwards, were no longer the black-faced variety named *A. petersi*, but a variety of the ordinary pallah, with much smaller horns than those of East and South Africa, the black patch between the ears more marked, and with other minor differences which may induce some zoologist to subdivide them from *A. Melampus*. The Oribi carried very big heads; I shot one with horns 7 inches long, and the coat was much brighter than the type met with on the Kunene. Like most of my other trophies the Oribi skins were abandoned through lack of carriers or have been lost, and the skull alone remains, to determine if the Kubango Oribi is a new subspecies.

We reached the Kwatiri, a tributary of the north bank of the Kubango, on July 8, and suspended our journey to explore this stream. For the first 20 miles we found the Kwatiri flowing through a swampy valley, bordered by higher undulating ground, which here and there might be

termed low hills. In the dry season the actual stream was only a few feet wide, but reed swamps extended for several hundred yards on either side of the running water. Further north the valley became narrower, but I understand from the natives that it opens out again in several places beyond where we penetrated.

Below the Kwatiri we canoed along beautiful stretches of the Kubango, where it ran between forest-covered hills, and the banks were shaded by big trees and occasional palms. Unfortunately the very nature of the scenery brought its difficulties, for what had been a placid river running in long and straight stretches soon turned to a rock-strewn stream running noisily over rocks, pebbles, and boulders, and sweeping in black swirls by larger rocks and islands, so that between the Makakutre stream where we had lunched and Shakandi island, a distance of 11 miles, we had only 4 miles of clear water in all, and passed thirty rapids or dangerous rocks and seven islands—a warning, had we heeded it, of what was yet to come.

We had heard that river navigation was difficult ahead, and fortunately took the precaution of sending our cameras and more valuable rifles by the carriers, who marched along the road; while for the last few days we had always removed our boots, gaiters, and anything we carried, like cartridges and binoculars, which could interfere with swimming. Having done this the rest had to be left to good steering, steady nerves, the luck of the occasion, and our capacity for saving ourselves once we were in the water. This capacity was tested the next day, when we were unable to clear a rapid: our canoe collided with another, and the occupants and contents of both were thrown into the surging stream, to escape with difficulty and not without damage.

The next day the rapids became less numerous, only eleven being met with in the 18 miles to Kwangar. We swept round a bend, to see a white fort, imposing and castellated, looking down on a long stretch of river, and across to a brick house perched on a knoll on the opposite bank. The fort was Kwangar, the Portuguese outpost of their frontier; and the brick houses formed the post of Kuringkuru, which had long flown the Imperial flag of Germany, but was now a portion of His Majesty's Dominions, the mandated territory of South-West Africa.

At Kwangar we found that carriers were unobtainable, for though the left bank of the Kubango as far as Libebes, sometimes called Andara on the map, continued to be Portuguese, the right bank was British, and possibly superior economic attractions had drawn the native population away from the Portuguese side to our own, and these people would not come down the river with us. So at Kwangar we took our courage in both hands and with rather troubled hearts committed all we had to a flotilla of three dongas, or canoes, and the end section of a small flat-bottomed pontoon boat, which our friend the Portuguese sergeant commanding Kwangar procured for us. We also added to our paddling

strength at Kwangar, for in addition to the one soldier and three policemen from Kaiundo, we were lent four more native police, and I managed to engage a native who spoke Portuguese. We had thus just enough men to man the little iron boat and the three canoes. None of the new men were good paddlers, but one could handle a pole, and had a certain amount of courage, so he was put in the tiny iron boat with a new man, while one of our old staff was placed at the steering end of each of the three canoes. Two of the canoes were sadly in need of repair when we first saw them at Kwangar, but with hard work, some pitch, rags, and cement, we managed to get them patched up before we started, besides making half a dozen new paddles.

We embarked our loads on the afternoon of July 19, our canoe leading the rest of the flotilla, which had orders to follow where we led, as the crews were such poor boatmen. Our proper course would have been to engage canoe-men from villages along the river, but the Ovambos were so unpleasant that we preferred to keep to our own people and steer our own canoes. There was no monotony in our journey, for if the eternal reed-fringed banks were changeless in their dress of white-topped green, the scenery alternated between grass flat and acacia-covered hillside, while here and there were beautiful palms, giant wild figs, and to the south baobabs. In the 200 miles between Kwangar and Diriko we passed twenty to thirty rapids, besides innumerable islands, submerged rocks, and reefs ; no tribute, I fear, to the navigability of the Kubango, if adding undue exhilaration to what might have been a long and monotonous journey. Here, as higher up the river, it was not surge and rapid alone that had to be feared, for on rock and sandbank, and even among the reeds, the head or ridged back of a crocodile showed us what might be our fate if the canoe upset on the rocks and we were swept on to the pools below them ; while the numerous hippo-tunnels in the reeds were reminders that this other danger of the river did not always wait for the river itself to bring about disaster, but could destroy canoe and man with a snap of enormous jaws. Just below Diriko, at the confluence of the Kwito and Kubango, six canoes and several natives had been destroyed by attacking hippo, and so great is their dread of these giants of the river, that many natives will only pass this confluence in daylight, and if possible in company with other canoes. I had always refrained from killing hippo, usually inoffensive beasts if unmolested, but on the Kubango, owing to constant molestation by man or some other cause, these quaint beasts have become a danger to navigation and must be destroyed.

Of the tribes of the lower Kubango valley, the Ba-Kwangar included the subtribes of Bunja and Sambio. The people north-west of the Kwito were under a chief called Niangana. South-east of the Kwito junction were the Mambukushu or Libebe's people. Below Kwangar, where the river divided Portuguese from British territory, nearly all the people were on the British side, having left the Portuguese or north bank of the

river in the last few years. Even above Kwangar the native population had been scarce, and we had only passed a dozen villages in our journey there from the Kunene, but below the post, Portuguese Angola was a human desert. We made many inquiries into the cause of the great migration and received many replies. The Portuguese gave the reason that the British, in order to obtain labourers, induced the people away with promise and hope of wealth; the Germans put it down to bad government of the Portuguese; while the natives, when questioned, said they were better paid on the English side. As neither Government inflicts any hut tax on the natives of the river, it was no fear of these taxes which has brought about this immigration, nor does the Portuguese system of conscripting soldiers affect it, as soldiers are not conscripted from the Kubango district of Angola. There is no official or systematic ill-treatment of the native by the Portuguese, as I have proved to my own satisfaction after much journeying through Angola. The main cause of the emigration is, I think, the economic factor, the attraction of payment in a more valuable coinage than the Portuguese escudo, and higher wages.

We suffered greatly from the unpleasant people of the Kubango, for from Kwangar downwards little help could be obtained to guide us to game, and although meat was given, its receipt was unaccompanied by any signs of gratitude. Food was sold at extortionate prices if the natives believed that our need was great. Help in need was grudged or refused. When the river became especially difficult, rapid succeeding rapid, submerged rock to sandy shoal, and one of our canoes after another had jammed on the rocks, we were forced to seek help, which was offered at a price, a bargain struck in a moment when our possessions were in danger of being swept away and lost. The further south and east we went the more detestable the native character appeared. Near the Mission of Njaro the venerable and kindly looking old chief Niangana had caused the murder of more than a dozen white men and women in his earlier days, rivalling the record of the chiefs of Andara or Libebe still lower down the river, where we camped in weary waiting later on.

Below Kwangar the river flowed through more open valleys, the rapids became less, and the open stretches of deep water were frequent, which was very fortunate for the untried canoes and boatmen. We covered 12 miles on the first afternoon, camping just above the Stopago rapids, in a country the natives called Nankutu. We had passed only seven rapids of all kinds, but near our camping-ground the open flats of the Kubango valley were intersected with many confusing channels. The country was sometimes wooded, with open and light forest; at others it had the appearance of a bush steppe, and here and there were flats which were obviously under water during the rainy season.

There was little game; no animals were seen, though spoor of reed-buck was found in the flats and that of duiker in the forests. On the second day of our journey what had appeared but a minor rapid nearly

KWITO RIVER AT DIRIKO

MAMBUKUSHU WOMEN

RAPIDS ON THE KUBANGO ABOVE LIBEBES

MEETING THE MAROTSE CHIEF LEWANIKA ON THE ZAMBESI

MRS. STATHAM AND BAMANGANDO THE RAIN-MAKER

brought us to grief; for three of the canoes went on the rocks, and my wife and myself found ourselves in the water. We managed to save nearly everything, though a good many of the loads were damaged by the wetting they got.

We stayed at an abandoned Portuguese post called Bunja for four days for rest and food, as game seemed plentiful, and included a small herd of buffalo. Below Bunja, which we left on July 25, the river continued to wind sluggishly through open valleys and grass flats, but what we lost in picturesqueness we gained in peace and security, for it was a delightful change to float with a feeling of comparative safety down this section of the river, where rapids were absent and rocks rare. In the stretch of river above Bunja there had only been three or four rapids, and in 30 odd miles below the abandoned post of Sambio there were only three in all: for the Kubango, a wonderful stretch of navigable river.

With our arrival at Bunja we had reached the centre of the land of the Ba-Kwangar, a people who lived on the left bank of the river till the Portuguese invaded the country and defeated the chiefs, who crossed the river with their people and remain there to-day, leaving the Portuguese bank deserted. During the last four days we had seen but one or two villages on the Portuguese side, while on the British bank these quaint mat-built villages were everywhere, many of them obviously only used in winter, when water was scarce except near the river; for on its right or southern bank the Kubango has scarcely any perennial tributaries.

The Ba-Kwangar dress in skin aprons, and long-bladed knives are often carried in the leather girdles of the men, and small antelope horns filled with snuff round their necks. The women wear skins and girdles as well, bangles round the ankles and arms, ropes of beads and ostrich-shell beads round their heads and necks and in the hair, which is usually twisted into fine plaits, lengthened by entwining them with vegetable fibre or beads.

Animal and bird life had increased as we went downstream; there were more roan and kudu; tsassaby and pallah (the common variety) were found in suitable places, and reed-buck and oribi were common. We came across a few steinbuck, and I saw what I took to be a reddish-coloured dik dik. A dozen miles south of Bunja we met "songwe," the Angolan Lechwe, again. At Bunja and between it and another abandoned post at Sambio we met traces of elephant and buffalo, and at Sambio saw a good deal of game, including wildebeeste.

As there has been an almost equal richness of antelope-life at the other abandoned post of Bunja, it is possible that the remains of the old plantations may have been an attraction. The bird-life south of Kwangar had been more plentiful, owing to great numbers of fish in swamps of the more open parts of the river.

We stayed three days at Sambio, which consists of two or three abandoned square huts but no attempt at fortification as at Bunja. Here

we killed a kudu and two tsessebe for food, and, having dried and cured the meat, pushed on down the river, which was reported to be more difficult and even dangerous to navigate lower down. We soon had all the difficulty and danger we feared, for 5 miles further down we met the first of the rapids, and within 8 miles had to navigate as many more without the help of any local canoe-men that knew the river, or expert paddlers to take us safely past its dangers. We nearly lost our own canoe in the maze of rapids and islands above Ntjarara, and suffered terrible anxiety in watching the two other canoes and the iron boat bumping their way through the swirling waters. The shallower rapids were not so dangerous, because from them we could probably have recovered our property, but in the deeper swirls the current was so strong, and in the deeper pools the depths so great, that anything which had been swept by the one into the other would never have been recovered, and some of us would have had a hard time to escape drowning.

As examination showed the river below Ntjarara to be continuously difficult for some miles, local aid was sought and obtained at an exorbitant price of 2 yards of cloth per paddler to steer the boats to Diriko. As a matter of fact we had only about 12 miles of difficult river voyage before we reached the deep clear stretches above the Kwito junction at Diriko, but it was a pleasure to watch our cheery villains of new boatmen, standing up to steer through swirling waters and black rocks, when our own men were crouching over their paddles, and obviously afraid. Once we were within an ace of disaster to our own canoe, which took the wrong passage, swept down between two rocks, and just bumped a submerged rock, the canoe being swept round and heeled to the surge of the water.

We arrived at Njaro German Mission Station on August 2, and at Diriko fort, placed on a cliff above the junction of the Kwito with the Kubango, the next day. The two Portuguese officers of the post received us most kindly, and told us that there was a good deal of game higher up the Kwito river. I decided to explore at least its lower reaches, while my wife rested at Diriko. The Kwito rises some hundreds of miles away in the Kwioko country. I had been within 60 miles of its source on my last journey in Angola, and was now watching its great flood of water, a deep stream some 40 yards across, pour itself into the Kubango, 500 miles from where it had started a tiny stream. In long stretches, one of the most navigable of rivers, it flows for the most part through open and often grassy valleys; but three or four times in its course, and for the last time 30 miles above Diriko, waterfalls break these stretches. The natives told me that this last fall was about 30 feet high. In its course, the Kwito passes through the lands among the Kwioko, Lushaze, Wachiwakee, Ambuella, and Ba-Kwito peoples.

The game of the upper Kwito consists mainly of roan and lechwe with reed-buck and oribi. Down near the mouth, and in the lower stretches, were elephant buffalo, rhino, and zebra among the bigger

animals, with sable, roan, wildebeeste, tsessebe, reed-buck, oribi, duiker, and steinbuck among antelopes. From the fort one could see a great stretch of country, and with the eyes alone, and of course more readily with binoculars, game was always to be found on searching. I believe that even lions have been seen in the early morning and late evening, moving after game or water, on this great plain which stretched for many miles along the left bank of the Kwito.

We reorganized our expedition at Diriko, sending all our loads of animal collections back up-river to Kaiundo with the men who were returning there; only the plant collection, a few animal specimens, and bare necessaries were carried on, as the river was reported increasingly difficult, and the canoes could only be lightly laden. The iron boat, which could never have survived the rapids ahead, was exchanged for a canoe. We came to some rapids near N'Dukoro island where the grey wacke zone of underlying rock comes to the surface, and near an island called Gangongo we saw a village which I was told was that of Bamangandu, who claimed to be the rightful heir to the chieftainship of the Mambukushu tribe. It was the first village of these people, that we were to get to know so bitterly well in the weary days at Libebes, and the terrible march across the sand-belts of the northern Kalahari.

The country of these Mambukushu extends along both banks of the lower Kubango, and between it and the river Kwando. Their chief village is on Tahoe island, near the Portuguese–British border, and the base of the Caprivi Strip. These people are said to have been among the earlier inhabitants of the country near the junction of the Kwando with the Zambezi, where they quarrelled so much that the Makololo chief, Sebituana, who had just conquered the Barotse valley, sent them further up the Kwando river to the swamp region called Mashe, where they settled and became the Ba-Mashe; to move again still further south to the Kubango river, making their first headquarters at Sibanana, one of the many islands in this portion of the river, Tahoe being another. Others consider they are allied to the Ovambos, whom they certainly resemble in appearance and habits. Libebe was the first of their chiefs; Libebe Andara, who is buried on Sibanana, the second; another Libebe, who probably poisoned his uncle, the third; and Lisho, who it is said murdered his predecessor in 1915, the fourth.

The Mambukushu and their chiefs suffer from a bad reputation, and have been condemned in the strongest terms by the few travellers—Schulz, Gibbons, Goold-Adams, Matabele Wilson, Streitwolf, and Seiner—who have met them and described them as treacherous, unreliable, cowardly, lying, and dishonest. Our experience fully confirmed their opinions, for Lisho, their chief, took advantage of our need of his help to extort an ever-increasing number of presents from us, while the carriers whom he had supplied on an advanced payment to take us to the Kwando, deserted us halfway, and curiously enough just where Goold-

Adams had been deserted by these people many years before. The worst sufferers at their hands were the Boer hunter Van Zyl and his wife, the husband being shot, and the wife blowing herself up with her baby, waggon, and a number of the scoundrels who had come to rob and claim her.

The Mambukushu chiefs are renowned rain-makers to whom even Lewanika and Khama appealed for rain. The rain medicine is said to contain the blood of a baby killed for that purpose. The hair is usually cut short in the men, and shaved over the forehead; by the women it is worn in long plaits, twisted well back, and occasionally with beads or small ostrich discs. The dress of both sexes is an apron of skin or cloth, suspended from a girdle and drawn between the legs, to be attached to the girdle again behind.

The Mambukushu are expert canoemen, for their chief village is on an island in the Kubango, with cataracts on every side, and all the river up and down for 20 to 30 miles is so rock-strewn and rapid as to be dangerous. To see them standing up in their canoes, plying their long pole-like paddles, and to watch them balancing long slender canoes with almost effortless grace, is to admire unpleasant people in spite of oneself.

Our last day's canoe journey was unforgettable in its scenery and sensations. The 15 miles of river between our last camp and Libebes was so continuously dotted with islands, and strewn with rocks, that every mile found us rushing past a reed-bank on one side, and a dark red reef on the other, or between two rocks of a reef where there seemed no possible passage in the river.

Libebes to the Kwando River.

While waiting at Libebes, where we arrived on August 9, we questioned the natives on the possibility of a further journey down the Kubango, and the nature of the country and water difficulties of the alternative route between the Kubango and Kwando. All the information I could gain as to the dangers of the lower portions of the river warned us against carrying out my original intention of continuing the canoe journey down the Kubango and by one of its channels, the Magwekana, to the Kwando, and then by the Zambezi to the Eastern Ocean, a plan which meant the navigation of the entire Zambezi system.

The Kubango was, I found, increasingly difficult below Libebes, and the falls at Popa, 15 miles down river, were 15 feet high. It was true that below the Popa falls the river was again navigable, but it was sluggish, swampy, and increasingly reed-choked, till the old connecting channel, the Magwekana, between the Kubango and Kwando, was reached. This watercourse, which some regard as the old bed of the Kubango, and others as an old spillway when that river joined the Kwando, is now rarely, if ever, navigable, and must tend to become shallower each year, with the silt of the muddy flood waters of the

Kubango, which still overflow into the Kwando at the end of the rainy season. The Magwekana was reported quite unnavigable, if not dry. Could we even reach the Kwando in safety, it would, we heard, be very difficult to continue our canoe voyage down this river, which becomes a tangle of almost impenetrable reed swamps. Apart from the navigation difficulties of any canoe journey down the lower Kubango or Kwando, were the dangers of the hippopotami which infested the marsh-like courses, and the millions of mosquitoes which buzzed above them, which Wilson has described as so numerous as to extinguish a candle with their myriad flying forms.

The alternative to this journey down a rock-strewn river, a drying-up old river-bed, and a mosquito- and hippo-infested swamp, was a 300-miles march across the northern Kalahari and over thirsty sand-belts to, first, the Kwando, then the Zambezi, where we would continue the canoe voyage. Before definitely deciding for the desert march, and against the river journey, I spent the week we stayed near Libebes examining some of the reaches of the lower Kubango and obtaining information as to the people and possibilities of the Kubango and Kwando swamps. My wanderings took me down the Kubango and towards the Popa falls. At Sibanana island, which we overlooked from Mukussu, and where Andara the first of the Mambukushu chiefs is buried, began the most striking portion of what has been called the "Gray Wacke" zone. For hundreds of miles the Kubango valley consists of sandstone overlain with sand and the primary rocks are practically never seen on the surface, but from above Libebes the Kubango passes through a zone of reddish-grey, grey wacke which has outcropped through the overlying calcareous and silicified sandstone beds.

The stretch of the Kubango between Libebes and the Popa falls is wonderfully picturesque. Everywhere are islands and rocks with foaming water in between, and the islands are so beautifully wooded, and the reddish rocks so jagged and quaint in form, whether in strange blocks or queer-shaped ridges, that this would be a painter's Paradise were it possible ground. What I had imagined of the Kubango was fulfilled in the beauty of the scenery, and unfortunately also in the impracticability of any further journey by canoes. We could of course have walked to below Popa, but I could not obtain any clear information as to the certainty of obtaining canoes or carriers lower down the river other than the small dugouts of the Makobas and Tannakwe bushmen, which were unfit to carry more than one passenger and one cargo-load.

This Tannakwe branch of the Bastard bushmen are a timid people, resembling Bushmen only in their features and speech, for their bodies are long, as are those of most swamp dwellers, and the arms developed at the expense of the legs. We could never have relied on such a timid and suspicious race nor on the Makobas to provide our requirements in carriers and canoes on the difficult reaches of the lower Kubango.

The desert march was now decided on, and we found that there were at least three routes from Libebes across the 200 miles or so of sand-belts, directly between the Kubango and the Kwando rivers. One going through the Caprivi finger, and another to the north of it, are but wet-weather routes, when the numerous intermittent watercourses contain pools of water; a third route further north is just possible till the end of August; later than this, in dry years, the natives stated that the safest way to reach the Kwando was to go first north-eastwards to a point on the Loengi river some 30 miles from its junction with the Kwando. The Mambukushu and Hukwe guides estimated that the journey by this route, which we decided to adopt, would take thirteen days.

We started on the seventh day of our wait at Mukusso, but it was impossible to leave even then without giving Lisho, the Mambukushu chief, final presents, in addition to the large number he had already extorted from us, and leaving the payment for the carriers with him.

The first day's trek showed the worthlessness of these men, who only succeeded in taking our loads, weighing 50 lbs. each, 9 miles, and declared that the first two water-holes of Kapungo and Shire, which proved to be 19 and 32 miles respectively from the Kubango, could not be reached in less than four days.

Up betimes to counter these delaying tactics, we continued the march north-eastwards for some 10 miles, halting at a large pan, where there was now but a little black and smelly water, obtained with difficulty by scraping away the sand from the bottom of a hole made in the pan. The conduct of our carriers on the first day's march had made me suspicious of their good-will, for they straggled continuously, tried to fall out of the line, and kept complaining of their inability to march without food, though they found a great abundance of "Mabula" plums and other forest foods on which they had been living for many weeks past. I did my utmost to procure food, leaving the path constantly to find game in the adjoining forest, but game was very scarce, and except for one eland bull of which we caught a fleeting glimpse, I never had a chance of killing a buck. The country round the Kapungo pan was also explored for game, and drinkable water, but neither was found, and the spoor, though it included that of giraffe, was scarce and several days old. On Seiner's map a pan is shown about 20 miles north-east of Libebes, which he calls "Korn pfanne," and which is probably that known to the natives as Kapungo. Here he found game and abundant bad water in August 1906, and here Goold-Adams met abundant game and a clear spring of running water in August 1896, while Schultz and Hammer, the first Europeans who passed through, at the end of August in 1884, found game abundant, and spoke of several large pans of water, at the same time of year when we found but a little filthy water and practically no game; evidence which corroborated the statements of the older inhabitants that the rainfall was getting less and the country steadily

drying up. At Kapungo we realized that there were other difficulties besides bad carriers. The track was over heavy sand, white when pure, yellow and brown when mixed with clay or alluvial, in the murambas, or shallow intermittent watercourses. The whole country is channelled by these numerous broad, shallow depressions, running south-east, roughly parallel to each other, and apparently towards the Kwando swamps. The formation is remarkable, suggesting an earlier and immense water contribution to the south-east, and possibly connected with the filling in or draining of that one-time great inland sea now the Kalahari desert. Towards the Loengi the murambas were less frequent, and we missed the blessing of the firmer soil which their alluvium provided, for the deep sand made walking exhausting.

The scarcity and badness of the water and my suspicions of the reliability of the natives decided me to abandon the longer north-east route to the lower Loengi, and march to its nearest point, which the maps showed us was only five days' march away. I marched a little east of north, in the belief that in that direction lay the closest point of the Loengi, hoping that some faint waggon tracks, which we discovered going northwards and were informed were those of a Boer waggon which had passed long before, were leading there. Wherever these tracks disappeared or went very wide of my proposed route I searched till we found them again, and it was fortunate that they always returned to the line of my proposed route. I wanted to follow these tracks because they gave us a direction and made me independent of unreliable native help, while I knew what marching by the compass alone would mean in this waterless bush. The tracks had been made long before and apparently in the rainy season when water was plentiful, and might have led me to where there had once been water and was none now. I dreaded lest my proposed direction and the waggon tracks should not coincide. Fortunately the tracks held to our direction, and 9 miles north from Shire pan they brought us to the dried-up pan of Kamuhoka, and 2½ miles further on to another, which one of the natives called Shu Shu. Now a pan with a similar name had been found by Goold-Adams in this neighbourhood seventeen years before. The native names for the pans vary with their languages, Mambukushu or Hukwe, etc., and for this reason and apart from native lying and unreliability, a water-hole may have at least two names, yet I felt cheered by the sight of the Shu Shu pan, dry though it was. Not far from Shu Shu pan was another called Didimbo, where Goold-Adams had taken a latitude of 17° 26′, and I tried to march there, but no one knew of Didimbo, and we never saw or heard of it on the route.

Two and a half miles beyond Shu Shu we found a pan, dry, it is true, but where the reeds were slightly greener, and I would have camped there to dig for water, when the natives, who had hitherto denied all knowledge of the route, said that a better chance of water lay at Likutu,

5 miles ahead. We continued the march and arrived at Likutu at sundown to find a 4-foot hole in the sand, but no water till we had dug another three, and then only a little soupy fluid. We let the boys have all this, and then cleared the mud and waited for the water to collect during the night. Long before daybreak the next morning an intense thirst drove me to the waterhole to drink, and fetch water for my wife, but we found the water-hole dry and the footprints of a bull giraffe beside it, though how he got his long neck down the 7-foot hole I do not know.

Having failed to coerce us to their own road, perhaps their own ends, on the first three days of the journey, the carriers still continued to play the delaying game the next day. Loads of 50 lbs. which had been readily carried all over Angola (the regulation load is 65 lbs.) must, they said, be carried by two men. By casting some loads and trophies this difficulty was overcome; but even so these Mambukushu would never move unless I came back to urge them. They flouted my wife's authority, and her distress was a source of amusement to them when I was not there. Only by a further sacrifice of all attempts at map-making, and by moving up and down the line, were the Mambukushu still pushed ever northwards, and towards the good water which we now knew could alone save us. As a last resource, the carriers pretended to fall down from weakness and want of food. That there was some famine in the land was undoubted, but the Mambukushu had been living on Magondo, M'Shibi, Mabula, Mabok, and other kinds of forest food for weeks past, were in good condition, and had more of this forest food on the march than at home. An unfortunate injury received in saving my dog from a wounded roan antelope added to our difficulties, but I was able to continue travelling, though in great pain, and succeeded in conducting the party for the next two days, and until near the Loengi, where I fell down from pain and exhaustion, and was carried to the river.

Of the eighteen carriers who started with us from Mukusu, I had hoped that the four Bastard bushmen of the " Hukwe " or roan antelope tribe, who gave less trouble and were the most useful in finding water and game, would prove reliable, but this was not the case, and they deserted us later on along with the Mambukushu to whom they are subservient.

These Hukwe, who live between the Kubango and Kwando rivers and are usually called Makwengo by the Mambukushu, and Mosarwa by the Marotse and Masubia, are as tall as the Bantus, and only their reddish-yellow colour, slanting eyes, small hands and feet, and clicking speech betray their partly Bushman origin.

Water is so precious to these people that they will keep its presence a secret even when those with them may be dying of thirst. They will pretend there is no water near, and that they do not need any, when they are really satisfying their thirst secretly, perhaps at night. This callousness seems dreadful till one realizes the treatment they receive from their Bantu neighbours, who steal their children, their weapons, and any of

the miserable chattels they may find in a Bushman encampment. These people are not brave, nor are they really good fighters, so that flight and cleverness in knowing and hiding in the forbidding desert country are their only chance of security. The bush to them is an open book; its game and the edible fruits and roots of its plants their only food; no wonder they will travel miles to reach some spot where the Mabula plum is still bearing, or some other fruit or root is approaching maturity.

The day after we reached the Loengi, Lisho's men deserted, taking all the meat supply of the camp. They deserted us on August 23, some 7 or 8 miles below where the Utembo joins the Loengi, at a village called Monkoyas, where there was a small Portuguese post with a couple of Askaris, who tried to help us to obtain more carriers. I made two attempts to reach Monkoyas and the river junction, but was too ill to complete the journey.

By the inducement of good wages, and through the belief that I was a Portuguese official with good authority, we collected enough carriers to take some of our loads, the others being left behind in the forest to be sent for as our retinue increased. Our other difficulty was the scarcity of food; grain was unobtainable, game was scarce, and the pain and physical weakness which affected me made hard hunting impossible. It was imperative, however, to obtain meat, as this is the hope and guerdon of every Mambukushu, for which he seems to think, work, and dream. Faint-heartedly scratching the smallest possible area of soil just before the rains, he trusts to Nature's tropical bounty to give him enough cereal food for his bodily necessity, the while he slaves to satisfy his hyena-like appetite for flesh by making snares, pitfalls, and falling traps for game.

Near a village called Yomba we had a mutiny among the carriers, who refused to move farther east. Paid and fed well, they had no reason for this refusal except the ingrained sloth and cussedness of their race, and I had no compunction in taking their spears and axes and forcing them along the path they had once promised to guide us, until at least they could find other people to take their places. My wife, myself, and the two Askaris took posts at intervals in the marching line of twenty men, who very soon saw that we were not to be continually trifled with, and after being watched and guarded for a day and night or two, they not only became reconciled, but joyfully helped us to find other carriers who could replace them. At Likoma, which we reached after a 16-mile march along the river, I found the first village marked as such in my map, and the chief, a man of about seventy years, gave me some very interesting information of the country and its villages. In a land where a village shifts every few years, and the headman after whom the village is called dies, naturally or with help, at almost equally frequent intervals, no map dependent on village locations can remain even approximately accurate. Only one of the mapped villages ahead of us

still existed under its former name, and even this one had changed its location. The chief told me, among other things, that from his village to where the Loengi joined the Kwando was four days' march, and there was a white man living at this point, and two others three days further south along the Kwando. Of the game of the country there were still giraffe, zebra, eland, wildebeeste, tsessebe, lechwe, reed-buck, duiker, and steinbuck; a few black rhino "Fume" were to be found, but of the white variety, the immense "Gava," none had been seen for many years, and it is doubtful if any survived. Likoma had killed some in his youth, and well knew these quaint and clumsy forms, with their long front horn, square mouths, immense bulk and comparative inoffensiveness.

Some lions had killed a bull giraffe a few days before our arrival, and the highly scented remains of its skin and bone. and what was left of the meat, were stewing in the fleshpots of the village.

The valley of the Loengi continued to increase in width, but kept most of the features which characterized it 30 miles further back; and the bed of the stream retained to an increasing degree its extraordinary tendency to meander. In this great valley, 2 to 6 or more miles wide, the tortuous reed-fringed stream, but 3 or 4 yards across, flowed very gently. The slopes of the valley were pretty, with clumps of trees growing on slightly higher ground, while running roughly parallel to the river, and often indistinguishable from it in appearance, were numerous reed-fringed lagoons, and the lower Loengi or Luiana continued like this to its junction with the Kwando.

At the junction we met a Greek who had a store, and who lent us a small waggon to continue our journey down the Kwando. We followed this river, which flows in an open flat valley to near Sepango just north of the northern boundary of the Caprivi strip, where the country becomes undulating and the river-banks steep. Here we met another white man. Since our return home these two lonely men have fought, and one has been killed, the other wounded.

From the Kwando to the Zambezi and the Victoria Falls.

A canoe journey down the Kwando being found impracticable, it was our unfortunate necessity to traverse the Caprivi strip as the only available road to the Zambezi. There are several routes across, between the Kwando and Zambezi, and most of them terminate at Moody's, 6 miles below Katima Molilo rapids. Two of them to the north, entirely or partially in Rhodesia, are not practicable at the end of September in a dry year. At this season it was necessary to pass south to Sekossi's old kraal, travel south-east and then north-east by a route where water was yet obtainable, and even here the natives said water was not found between the Kwando and Sebindi spring, near Malindi pan, and some 40 miles by road from our starting-point. All our water for this journey had to be carried

We entered the Caprivi strip when we passed south of the Kimbashi tributary of the Kwando near where Mbala's village is marked on the map. Three miles further south was another and much larger water-course now nearly dry, the Lublainga, which joined the Kwando where a little Sekossi village once stood, and just north of where Sinjenda is marked. From here for 40 miles eastward was the waterless stretch. The Lublainga means, I think, "the place of the killing," for native tradition says that in this arm or tributary of the Kwando were once, in the days before the droughts, a great extent of water, reeds, and numerous hippo. Vast numbers of these hippo were killed by spearing them with iron barbs to which a rope and float of light wood were attached, which showed the position of the wounded hippo when submerged. When the enraged and harried hippo were driven ashore, they were speared to death with assegais.

On the second night we camped 27 miles from the Kwando and near one of the big Murambas or river-beds which appear to run towards the Chobe section of the Kwando, but were fewer though larger than those seen between the Kubango and Kwando.

From Malindi pan we marched northwards along a Muramba which appeared to run from the north-east and the Zambezi, south-west towards the Kwando. The pans on this march were Getsi and Katongo, and we also passed two villages, but as the unfortunate people move constantly to be near water, a village is a dangerous signpost to give any traveller in this part of Africa. The next day we camped at M'batcha pan, passing that of M'beha on the road. There were two other villages near here, Musukowera and Musokopeka, and the path still seemed to follow in a Muramba running from north-east to south-west. From M'batcha pan a march of over 20 miles brought us to the Zambezi.

Some 10 miles from Malindi the country opened up into park land. Green shoots were struggling through the charred stalks and ashes of the late grass fires; the trees wore their dress of spring, and game was fairly plentiful again. Beyond Malindi pan began the area of Mopane forest—that widespread curious plant which grows from so many stems, yet never forms a thick forest owing to the interval between individual trees, and yields so little shade because of the upright position of the leaves. Fringing the Zambezi in the undulating country near Katimo Molilo were great trees, but further downstream such trees were far from the reed-covered banks, which are under water for part of the year.

The soil between the Kwando and Zambezi, as between the Kubango and Kwando, had been sand, heavy when pure, usually harder when mixed with clay and alluvial soil; for all this belt is geologically but a portion of the great Kalahari formation, sand over sandstone and lime-stone. We first met the sand near the Kunene, and lived in it for months and over 1000 miles. We bade good-bye to it near the Zambezi, and shed no tears at the parting.

Our further canoe journey was uneventful, for we obtained a canoe barge and a dozen skilful Marotse paddlers at Katima Molilo, who took us down the 100 miles of river to Katimbora in two and a half days, and through the Mambova rapids near the Zambezi–Kwando junction with the ease born of wonderful skill. The sense of security and the monotony of the flat reed-fringed banks were a relief after our hazardous canoe journey and weary marches, and the Zambezi was too well known to study afresh. The 40-miles journey in a large waggon drawn by sixteen oxen from Katimbora to Livingstone and the Victoria Falls was an equally pleasant contrast to the anxiety and fatigue of guiding our little two-wheeled waggon through the roadless forests of the Kunene and saving it from continual threats of disaster.

Before the paper the PRESIDENT (the EARL OF RONALDSHAY) said: For the opening meeting of our session we have turned once more to that fertile field of travel and exploration, the Continent of Africa, and we have been fortunate enough to secure as our lecturer Colonel Statham, whose knowledge of many parts of Africa, and particularly of Portuguese West Africa, is well known. He will conduct us this evening for some fifteen hundred miles from Mossamedes, a port in the south of Angola, eastward across the heart of Africa until he drops us at the Victoria Falls. I am not quite sure what the particular object of Colonel Statham's journeys has generally been, but I rather suspect that a not unimportant object is the hunting of wild game, for I happened to learn, incidentally, that in the course of his travels in different parts of the world he has had violent encounters with wild animals on no less than three occasions. He was mauled on one occasion by a bear in India; he was run over on another occasion by a rhinoceros somewhere in East Africa; and on the journey which he is to describe to-night he had the misfortune to be knocked out by some form of African antelope who was in the process, I understand, of killing his favourite dog. No doubt Colonel Statham, who is a scientific man, having been for many years a member of the R.A.M.C., kept the eye of the scientist open as well as that of the hunter, and he will have much to tell us to-night of an important problem which confronts those interested in the country over which he travelled, namely, the gradual drying up of the series of rivers which run north and south in that part of Africa and which now, I believe, practically lose themselves in the Kalahari Desert. But you will desire to hear of all these things from Colonel Statham's own lips, and I shall not stand longer, therefore, between you and the lecturer.

Colonel Statham then read the paper printed above, and a discussion followed.

The PRESIDENT: There are very few who are competent to say anything at first-hand on the subject of the lecture to-night, but by far the greater part of the territory which has been described to us lies in Portuguese Africa, and we are honoured to-night by the presence of His Excellency the Portuguese Minister, Senhor de Bianchi, and we should be grateful to him if he would say a word or two on the lecture.

His Excellency the PORTUGUESE MINISTER (Senhor Y. A. de Bianchi): Besides the geographical, historical, and scientific interest in this lecture, which I appreciated immensely, there is one point which impressed me very much, namely, when Colonel Statham said that he had received from all the Portuguese

representatives he met during his long, tiresome, and dangerous journey every assistance they could give him. I do not think it is the first experience of that hospitality, and I am sure it will not be the last. I know that in our colonies, all scientists, all men who try to study Nature in one way or another, are always welcome and can always depend on having the best assistance that can be given them.

There is another point that also interested me, and that is the utilization of the waters of different rivers for the purpose of flooding the dry regions, and as a matter of fact I have been in practical touch with a scheme, which is that the South African Government seriously consider driving part of the Kunene into the Ovampo. I do not want to dilate upon the results derived from the scientific observations which Colonel Statham has referred to to-night, but I may say that we are feeling the results of the drying up of that part of Africa in our own territory; all the territory on the right-hand side of the Kunene is drying up, and the overflow that used to make that country fertile has diminished and turned it into an almost barren land. Further, that country has consequently been deprived not only of the water but also of the natives. There has been a continuous drainage of the native tribes, as it were, following the water. As the water has dried up, so the population has dwindled and disappeared. That is one of the facts that I believe proves, in the run of several years, the statement that Colonel Statham has so interestingly put before us. Besides this, Colonel Statham has brought us into touch with all that African territory and the animal life he found, which interested all who have followed his description and his pictures of the whole journey. I am very grateful to him for the kind words he has said of the Portuguese, and I believe that I express the feeling of everybody present when I say that we thank him for the very clear and interesting lecture which he has given us.

The PRESIDENT: If there is no one else who feels any desire to say a few words upon the country which we have heard described to us to-night, I would venture, on your behalf, to express to the lecturer our great appreciation of all that he has told us and the manner in which he has told it to us. His lecture has certainly shown that if he is a hunter of big game he hunts with a camera as much, indeed, if anything, more than with the rifle, and much, if I may say so, to our advantage. Some of the photographs of animal life which he has shown us to-night are assuredly of quite unusual interest. The journey which he has described has also been full of exciting episodes. Indeed, it seems to me to have been about as exciting a journey as one could expect or perhaps wish to undertake in the twentieth century, and our congratulations are due, I think, both to Colonel Statham himself, and to Mrs. Statham in particular, upon their safe return from the arduous task which they undertook. We are even more grateful, perhaps, than some of you realize to Colonel Statham for giving us this lecture to-night, for he is still suffering from the effects of the hardships which he has encountered in his recent and previous journeys. And in view of the fact that he has been suffering for some weeks past—and is even now not free from the scourge—from acute malaria, it redounds greatly to his credit that he should have brought himself to the scratch and have given us so interesting and informative a lecture this evening. He will, I am sure, accept your applause as the measure of your gratitude to him.

ABNORMAL DENSITIES IN THE EARTH'S CRUST DISCLOSED BY ANALYSIS OF GEODETIC DATA

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Read with the following paper at the Afternoon Meeting of the Society, 12 November 1923. *Discussion follows on page 35.*

THE first comprehensive test of the Theory of Isostasy was made by Hayford of the United States Coast and Geodetic Survey,* when he used the latitude and longitude determined in the United States by astronomical observations and by direct measurements in the form of triangulation. Hayford assumed that, under each topographic feature, there is a deficiency of mass exactly equal to the mass of the feature, that the deficiency is confined to a layer terminating at a uniform depth below sea-level, and that the deficiency is uniformly distributed vertically. It was necessary to assume some such ideal conditions in order to make feasible the vast amount of computations involved. Besides, it was as reasonable a set of conditions as any other which might have been adopted.

Hayford's researches indicated that the theory of isostasy is substantially true. This is shown by the fact that he obtained deflections of the vertical only ten per cent. as large on an average as computed deflections on the rigid Earth hypothesis. The work done in India by Burrard and his assistants, and in the United States by the author, has so extended the knowledge, gained from Hayford's work, of the isostatic conditions of the Earth's crust that we may now draw some quite definite conclusions.

Values of the intensity of gravity have been used in the latest work; and while it cannot be said that gravity results are more effective than deflections of the vertical in isostatic research, I shall use the results from the application of gravity in what follows. The same assumptions regarding the isostatic condition of the Earth's crust were made when computing the effect of compensation on the value of gravity that were used in the investigations of deflections of the vertical and isostasy.

Assuming for the moment that a state of perfect isostasy obtains, then there will be a surface, defined by what is called the "depth of compensation," concentric with the sea surface, which limits the deficiencies and excesses of density. Also, as the balance is maintained during erosion and deposition, there will be a flow of matter from the loaded to the unloaded column, and this flow is called the "isostatic adjustment." The deficiency of mass in the crust under the elevated land areas and the excess under the oceans is called the "isostatic com-

* 'The Figure of the Earth and Isostasy from Measurements in the United States, 1909.' Supplementary investigation in 1909 of the Figure of the Earth and Isostasy, 1910.

pensation," or simply the compensation. The layer within which the isostatic adjustment occurs is called the " layer of flow."

It is impossible that the Earth's crust is in such a state of isostatic equilibrium that each small vertical column of unit cross-section has the same mass. One of the problems is to determine the cross-section of the column which is independently in isostatic equilibrium. It does not seem to be at all probable that all of the isostatic compensation of a topographic feature, as for instance a small mountain peak, is directly under the peak. We therefore must try to discover the extent to which the compensation may extend horizontally from a topographic feature.

We have assumed uniform distribution of the compensation with the depth. This is, of course, an artificial assumption, so we should try to learn the true method of distribution and whether it varies from place to place. It is improbable that the depth of compensation is a definite surface at a uniform depth below sea-level. We must endeavour to learn from the data available whether there is a limiting depth to the compensation, its distance below sea-level, and whether it varies from place to place.

It does not seem possible that for even large blocks of the Earth's crust, the isostatic balance is perfect. Therefore we should determine, if possible, the degree of balance. We should determine the position of the layer of flow, if practicable.

The isostatic researches have thrown some light on the problems outlined above.

1. Gravity Reductions.

Values of the intensity of gravity have been used in the investigations covered by three reports of the U.S. Coast and Geodetic Survey.* In the latest of these publications, 374 stations are used. Of these 219 are in the United States, 42 in Canada, 73 in India, and 32 in Europe. The differences, called anomalies, between the observed and the computed values of gravity are the essential data. The computed value is the theoretical gravity at sea-level for the latitude of the station, with corrections applied for the elevation of the station above sea-level, for the attractive effect of masses above sea-level and the deficiencies in density in the oceans, and for the attractive effect, negative or positive, of the isostatic compensation.

If there were no deviations from the ideal isostatic state, the differences between the observed and computed values of gravity would be due only to the unavoidable small errors incident to the observations made with pendulums to determine the value of gravity. The differences found are, on an average, much larger than the errors of observation.

* ' Effect of Topography and Isostatic Compensation upon the Intensity of Gravity, 1912,' special publication No. 10; Same, second paper, 1912, special publication No. 12; ' Investigations of Gravity and Isostasy,' special publication No. 40, 1917.

It is with these differences, called anomalies, that we are enabled to learn something of the isostatic condition of the Earth's crust. The isostatic gravity anomalies are on an average only 15 per cent. of what the anomalies would be if the Earth were rigid. This is the most important fact resulting from our investigations, for it shows that the Earth's crust is within a small percentage of being in complete isostatic adjustment.

In the Bouguer method of reducing gravity data no account is taken of the isostatic compensation. The average and maximum Bouguer and isostatic anomalies per station in the United States are given in the following table. Each of four groups of stations was treated as a single station by taking the mean anomaly for the group.

	Number of stations or groups.	*Average without regard to sign. Dyne.*	*Average with regard to sign. Dyne.*	*Maximum. Dyne.*
Bouguer anomalies	296	0·048	−0·036	0·229
Isostatic anomalies	296	0·021	−0 006	0·093

Of the 296 anomalies, 208 of the Bouguer are negative and 87 are positive, while of the isostatic 168 are negative and 126 are positive. The average Bouguer anomaly without regard to sign is 2·3 times as large as the isostatic. The average Bouguer anomaly with regard to sign is −0·036, while the isostatic is only −0·006. This is strong evidence in favour of the theory of isostasy.

2. Relation of Anomalies to Topography.

A very severe test of the theory of isostasy is given by the relation of the anomalies to the elevations of the stations. This test will show whether the anomalies are different for the various topographic conditions. In the following table are given the average Bouguer and isostatic anomalies in the United States for various elevations.

		Average Bouguer anomalies.		*Average Isostatic anomalies.*	
Elevation in metres.	*Number of stations or groups.*	*Without regard to sign. Dyne.*	*With regard to sign. Dyne.*	*Without regard to sign. Dyne.*	*With regard to sign Dyne.*
0– 400	213	0·027	−0·010	0·022	−0·010
401– 800	32	0·039	−0·037	0·018	+0·011
801–1200	16	0·104	−0·104	0·022	−0·004
1201–1600	15	0·128	−0·128	0·022	+0·010
Over 1600	20	0·184	−0·184	0·014	+0·003

We find very nearly the same values for the average isostatic anomalies for the five groups of elevations. On the other hand, the Bouguer anomalies have a very definite relation in size and sign to the elevation. This test is strongly in favour of the isostatic theory.

3. Relation of Anomalies to the Geological Formation.

There are anomalies whose sizes seemed to indicate decided departures from the isostatic condition for the regions surrounding the stations, but

many of these have been shown by the author to be caused by the presence of extra light or heavy matter near the stations but below sea-level.*

It is well known that the average density of pre-Cambrian rocks is greater, and that the average density of material of the Cenozoic formation is less, than the average density of surface rocks.

There are 133 Cenozoic stations in the United States, Canada, and India, of which 88 have negative signs. Only 43 have positive signs.

Of the 39 pre-Cambrian stations in the United States, Canada, and India, 28 have positive signs and only 11 negative signs.

Of the 164 stations having anomalies greater than the average, 0·021 dyne, 57 are on Cenozoic formations and 20 on the pre-Cambrian.

There are 44 stations, in those countries, having anomalies greater than 0·040, and 31 of these are on the Cenozoic and the pre-Cambrian formations.

These relations between the size and sign of the anomalies and the Cenozoic and pre-Cambrian formations have a peculiar significance, for they enable us to account for many large anomalies, which otherwise would be attributed to a lack of isostatic equilibrium. The sizes of the Cenozoic and pre-Cambrian anomalies are related to the thickness of these formations near the stations affected. No definite tests have been made in this country of the probable depths of these formations based on the sizes of the anomalies, but some work along this line has been done by Burrard in India.† He computed the thickness of the Cenozoic material which would account for the anomalies, although these values may not be and probably are not the real thicknesses of the formation. The problem is a complicated one and the most we may expect from such tests is the order of magnitude of the thickness.

Columns under Cenozoic or pre-Cambrian formations can be in isostatic equilibrium and still have large gravity anomalies, for the extra light or heavy material near the stations will have far greater effect on gravity than the compensating increase and decrease in densities which are distributed throughout the columns and are at much greater distances from the station.

It is reasonable to assume that the negative isostatic gravity anomalies on the Cenozoic formation do not indicate a light Earth crust block, for the Cenozoic area has been subjected to heavy sedimentation within recent geological time; and as the Earth crust block is sinking under the sediments as they are laid down, it is not probable that the block is light as might be inferred from the gravity anomalies. Relatively light blocks do not sink. It is only the heavy ones that do. We are safe in concluding

* 'Investigations of Gravity and Isostasy,' Special publication No. 10, U.S. Coast and Geodetic Survey.

† 'Investigations of Isostasy in Himalayan and Neighbouring Regions," by Col. Sir Sidney Burrard, Prof. Paper No. 17, Trigonometrical Survey of India.

that the Cenozoic blocks are as nearly in isostatic equilibrium as the other blocks of the Earth's crust.

The pre-Cambrian areas have been subjected to erosion for great geological time, and still the gravity anomalies on this formation would indicate that the Earth crust blocks under this formation are extra heavy. These show evidences of having maintained their elevations, which means that the isostatic adjustment has occurred and the eroded matter has been replaced by material added in the lower part of the column. The columns under an area which has undergone erosion for a long period should be lighter rather than heavier than normal. A block heavier than normal should sink, not rise. We are justified in reasoning that the pre-Cambrian blocks are in as close a state of isostatic equilibrium as the average of the other blocks.

I have discussed the Cenozoic and pre-Cambrian anomalies in some detail, as the isostatic condition of the blocks, especially under the Cenozoic formation, has great importance in the application of the theory of isostasy to geological processes involved in mountain forming.

No one knows how the compensating deficiencies and excesses of mass are distributed vertically with respect to the topographic feature. But we do know that the outer portion of the Earth possesses some resistance to horizontal movements, and we also know that somewhere below the resisting crust the material must yield to the stress differences set up by erosion and deposition. If it were otherwise, there could be no hydrostatic equilibrium of the Earth's crust.

The plasticity of the material below the crust must be caused by the conditions of temperature and pressure existing within them. As these should be practically the same for any given layer, the degree of plasticity should also be about the same throughout the layer. It seems reasonable to conclude that the change from material which resists movement to material which is plastic must take place within a layer (concentric with sea-level) of moderate thickness—tens rather than hundreds of miles.

In determining the differences in mass between portions of the Earth's crust which have the same cross-section and extend to the same depth below sea-level, the datum used in the computations of the topographic effects is unimportant. Sea-level has been generally used in the isostatic investigations, but any other surface, whether above or below sea-level, could have been used with equal effectiveness. With the use of sea-level as the datum, normal crustal density is assumed to be that of the columns whose upper surfaces are at zero elevation. Should some other datum be used, then normal density for the crust would be that of columns having their upper surfaces coincident with the datum. With a different datum the isostatic compensation expressed as percentages would be different, but the deflections of the vertical and the gravity anomalies would be very nearly the same, regardless of the datum used, and it is

these quantities which are used in deriving the degree of perfection of the isostatic condition of the Earth's crust.

4. Reliability of Data.

We may safely say that the pendulum observations, the value of gravity computed by the gravity formula, the correction for elevation, and the computed effect on the station of the land masses and the deficiency of matter in the oceans are accurate within less than 0·005 dyne, or five parts in one million of the total force of gravity. The only uncertainty is in the computed effect of the isostatic compensation. This is because we really do not know anything about the compensation except in an indirect way. But are we not justified in saying that the computed effects of the isostatic compensation are very reliable? By applying these corrections to the gravity values we reduce the anomalies to about one-seventh or one-eighth, on an average, of what they would be if the Earth were rigid. The isostatic anomalies might be somewhat lessened if we knew the actual densities of the rocks near the gravity stations, both above and just below sea-level.

The reliability of the corrections for the effect of the isostatic compensation is also indicated by the fact that the methods employed are generally applicable. The method is successful in the United States, in Canada, in India, where it has been extensively employed, and in Europe, where only a few gravity stations have been used in the isostatic investigations. Any method of distributing the isostatic compensation which is generally applicable to gravity results cannot be materially different from the one now employed. We may therefore say that the computed effects of the isostatic compensation on the intensity of gravity have a high degree of reliability.

5. The Distribution of the Compensation horizontally.

It does not seem possible that the compensation of a small topographic feature can be located directly below it, for the Earth's crust certainly has enough strength to hold up such a local load. To be compensated locally would imply an almost total lack of crustal rigidity. It does seem to be probable that individual mountain peaks and their bases are compensated within a reasonable distance horizontally from the peak.

A test was made to discover, if possible, the distance around each of a number of gravity stations to which the compensation of the local topography may extend. It is evident that the most reliable information can be obtained from a consideration of the stations in mountainous regions. The results of the test indicate that the effect of the compensation, distributed around a mountain station to a distance of 40 miles, eliminates the gravity anomalies to about the same extent as does the local distribution. The results show that the anomalies are not so well eliminated when the compensation is distributed to a distance of about

100 miles from the stations. The problem really cannot be definitely solved, but it seems to be a reasonable assumption that the compensation is not strictly local, but that it is distributed in the Earth's crust around the separate features for a distance somewhat less than 100 miles.*

This question of the horizontal distribution of the compensation must not be confused with the question of the magnitude of the topographic mass which may entirely escape compensation. It has been found that for gravity stations at elevations greater than 1000 metres (about 3300 feet) we cannot ignore the compensation of the topographic mass near the station out to a distance of 18 miles without greatly increasing the anomalies. In a test of this question † forty-two gravity stations were used. The results show that, should the isostatic compensation of the mass out to a distance of 18 miles be ignored, the average anomaly would be double the size of the anomaly based upon the hypothesis that no topographic masses escape compensation. If the compensation of the topographic masses about the station to a distance of 36·5 miles from the station is neglected, the mean value of the gravity anomaly is nearly four times as great as for complete compensation.

As the extent to which gravity anomalies can be eliminated by a generally applicable method is a measure of the reliability of that method, we must conclude that the theory that all topographic masses are compensated is nearer the truth than one which may hold that masses as great as 3300 feet in thickness and 36 miles in diameter may escape compensation. It is probable that even the ignoring of the compensation of a disc of the above thickness and only 10 miles in radius would give greater irregularities in the gravity anomalies than we find in the anomalies when the compensation of all masses is considered.

6. The Definition of Isostatic Compensation.

It has been rather unfortunate that the expression "isostatic compensation" should have been applied to the deficiency in density under land masses and the excess in density under the oceans. It would have been far better to have used some other term or expression for these deviations from normal densities, for these deviations are the causes of the irregularities in the surface of the Earth. The mountain masses really compensate the deficiencies in density under them, while the lack of mass in the oceans compensates the excess of density under the water. The deviations from normal densities in the Earth's crust are the causes of land masses and water areas rather than the effect of them. As the word "compensation" has been used for such a long time for the deviations from normal densities, and as the exact significance of the term

* "Our Present Knowledge of Isostasy from Geodetic Evidence," July–August, 1917 number, *Journal of Geology*, pp. 429–432.

† "Some Geologic Conclusions from Geodetic Data," *Proceedings of National Academy of Sciences*, vol. 7, No. 1, pp. 23–28, January 1921.

has become rather generally known, probably it will be well to continue its use.

7. Relation of Isostasy to Geological Theories.

The theory of isostasy has been used to only a very moderate extent by geologists in explaining the various geological phenomena of the Earth. If the Earth's crust is in isostatic equilibrium, and this seems very probable, then we are justified in assuming that the isostatic condition has obtained since earliest geological times. It is apparent that the isostatic condition of the Earth's crust should be taken into account in formulating any theories regarding structural and dynamic geology at least for areas of considerable size. By considerable size, I have in mind an area as large as 100 square miles.

The isostatic investigations show that the theory of isostasy cannot explain the formation of a mountain, but that it can explain the maintenance of a high region in approximately the same elevation during the process of erosion. The original uplift of a mountain area must be due to a change of density in the Earth's crust beneath the affected area, rather than to transfer of material from other columns into the ones which are being uplifted.

There apparently is no possibility of discovering exactly the upper limit of the layer within which material moves from a loaded toward an unloaded portion of the crust. It is reasonably certain that the horizontal flow takes place below the crust, which is composed of material resisting horizontal movements. As the depth of compensation is a mean depth to which the isostatic compensation extends, this depth must be somewhat above the mean lower surface of the crust; therefore the isostatic adjustment to restore equilibrium must occur below the depth of compensation. Since the isostatic adjustment is deep-seated it seems that the movement would have little effect on the configuration of the surface of portions of the crust lying between the two areas which are not in equilibrium.

The theory of isostasy has, to a large extent, been investigated and developed by geodesists, but future developments and progress in the study of this theory must be made along geological lines.

DOUBTS AND SUGGESTIONS ON TERRESTRIAL ISOSTASY

Captain Alberto Alessio, D.S.O., R.I.N.

Read with the preceding paper at the Afternoon Meeting of the Society, 12 November 1923.

IN a critical investigation on the theory of terrestrial isostasy, published as a supplement to the *Rivista Marittima* for March 1921, I have put forward certain doubts and suggestions, of which the following is a summary:

1. The United States Coast and Geodetic Survey, under the direction of Mr. Hayford and later of Mr. Bowie, first made calculations founded on the isostatic hypothesis which we may call Hayfordian, with the object of making a general verification of the theory of compensation on Pratt's hypothesis. Upon what was in reality only an artifice of calculation they afterwards based a physical theory, and in the results of their observation and calculation they thought they had discovered a verification of this theory, whereas it still remained open to discussion whether the hypothesis of compensation was in fact verified.

According to the hypothesis of complete compensation the visible excesses or defects of matter on the Earth's surface are compensated by interior defects or excesses which are strictly equal and placed in the same vertical. The Hayfordian did no more than specify precisely for the necessities of computation how and when the compensating excesses or defects were distributed. When the U.S.C.G.S. concluded that they had ascertained the concordance of the elements computed on this assumption with the facts of observation, they accepted the Hayfordian hypothesis as demonstrated.

2. Now the field of force of terrestrial gravity, being observed only in a limited number of points may be produced in an infinite number of ways by appropriate distributions of density: and even if one admits the complete correspondence between hypothesis and fact in the elements observable—the direction of the vertical and the acceleration of gravity—the Hayfordian distribution would be only one of these possible distributions, infinite in number.

3. But serious doubts arise. The application of the method of least squares has its value in the numerical determination of unknowns whose existence is positively ascertained. But every additional variable introduced into the equations of condition arbitrarily diminishes the sum of the squares of the residuals, and even if it does not correspond to actual facts, may appear to give a probable value to unknowns thus introduced.

Thus, if instead of introducing as an unknown quantity the depth of compensation we had introduced as unknown in the equations of condition the densities of the surface irregularities, the mountains and the ocean, we can, by applying the method of least squares to the discussion of the observed deviations of the vertical in the United States, find that the most probable value of the density of continents and mountains is 0·3 instead of 2·67, and the density of the sea-water 2·5 instead of 1·03. These results are of course absurd, but their mathematical justification is as good, in my opinion, as that of the isostatic theory.

To a certain extent the Hayford theory may be admissible. But its author should have been surprised when, confronted with the sums of the squares of the residuals resulting from his different assumptions of the depths of compensation, he found first a great diminution when he

passed from the assumption of the rigid Earth (depth of compensation infinite) to the evidently absurd hypothesis of no effect of visible masses (depth of compensation zero), while the further diminution was quite small when he passed from this to the assumption of various small depths of compensation. This ought to have warned him that it was an illusion to suppose that he could thus arrive at the distribution of internal masses.

4. Besides the above fundamental objections, there is another criticism to be made. The spheroid of reference ought to have been that which would have existed if all the matter had been free to arrange itself under the action of gravity and centrifugal force: that is, a solid spheroid covered everywhere by a layer of water 2500 metres deep. It would be better to adopt as the "normal gravity" the quantity representing this ideal state.

[The above statement, condensed from an abstract of the complete paper in the *Rivista Marittima* kindly furnished by Captain Alessio, represents the essential points in his argument against the Hayford theory. A more complete account of the argument, with many other criticisms and suggestions, will be found in the original, of which a copy has been presented to the Library of the Society.—ED. *G.J.*]

Before the papers the PRESIDENT (the EARL OF RONALDSHAY) said: The subject of our first afternoon discussion is Isostasy. Neither of the authors of the two papers which will form the subject of our discussion is present this afternoon, and in these circumstances Mr. Hinks will give to the meeting a summary of the arguments contained in the two papers. The paper which puts forward the arguments in favour of isostasy is by Mr. William Bowie, Chief of the Division of Geodesy of the United States Coast and Geodetic Survey at Washington. And the author of the paper which criticizes this theory is Captain Alberto Alessio, who is at the present time the hydrographer to the Italian Navy. While it is, I think, more than probable that there will not be many who will find themselves in agreement with Captain Alessio, yet the position which he holds undoubtedly entitles him to be heard.

Mr. HINKS *in summarizing the two papers said*: The most interesting point in Mr. Bowie's paper seems to me to be this: that he is tending away from the artificial conceptions of Hayford, with a rigidly defined uniform depth of compensation, towards something much more resembling the old flotation hypothesis, though different in detail; at least, that is how I interpret the phrases about extra heavy blocks maintaining their elevation in spite of denudation, of eroded matter replaced by material added in the lower part of the column, and of the horizontal flow required to produce this taking place below the crust. "No one," says Mr. Bowie, "knows how the compensating deficiencies and excesses of mass are distributed vertically with respect to the topographic feature"; but it seems to be in the author's mind that in the above case we have material extra heavy above compensated by extra light below, and the column rising as the top is eroded, with filling in of plastic but presumably heavier matter again below. If this interpretation is correct, it is a long way from Hayford's uniform density in a column down to the lower limit of compensation.

Captain Alessio's objections to the whole Hayford theory, as set out

above, have been condensed from a much longer statement sent by him as a summary of his original publication in the *Rivista Marittima*. The figures of Hayford's 1910 solution are:

	Assumed depth of compensation.	*Sum of squares of Residuals.*
Solution B	Infinite	107,385
A	Zero	18,889
E	162·2	10,297
H	120·9	10,063
G	113·7	10,077

One would sympathize with Captain Alessio if he had contended only that there is really nothing to choose between the last three: that to interpolate as Hayford did, and derive 122·2 as the depth of compensation, is indefensible. But further than that it seems difficult to go with him, unless one takes the perhaps extreme view, which I have heard expressed by Sir Joseph Larmor, that no observations made outside an equipotential surface can tell one anything certainly about the inside. If that formally correct mathematical proposition is really a bar to these geodetic investigations, the sooner we agree upon it the better.

The PRESIDENT: In the course of his paper Mr. Bowie has made more than one reference to the work of Sir Sidney Burrard on this question in India. He is, happily, present this afternoon, and I ask him to speak.

Sir SIDNEY BURRARD: When I read the two papers, of which Mr. Hinks kindly sent me proofs, I thought that the main question at issue this evening would be: Is Hayford's theory of isostasy correct or not? And that being the case I think that it is rather premature to discuss such questions as horizontal layers of flow until we have settled whether the main theory is to be accepted.

There is one fundamental point upon which I do not agree with Mr. Hinks. I do not think that Bowie has separated from Hayford. I read Bowie as a continuation and modification of Hayford. I first heard of Hayford's theory from Prof. Helmert, who was the foremost geodesist of the age, and that was about fifteen years ago. He had then been working at this problem for about twenty years, and he seemed to recognize, though I thought with sadness, that Hayford had hit upon the solution which he had been vainly seeking. When Hayford's method had been introduced into India we realized that it would mark an epoch in the history of geodesy. It explained our observations better than any former hypothesis. At the same time, it did not fit the observed facts in the Himalayas so accurately as it had fitted those in America. Five years later Bowie supplemented and completed Hayford's theory by showing that in calculations of isostasy we must take into account the varying weights of the surface rocks composing the mountains. Hayford took the first great step of showing us how to calculate the compensation of the visible topography, and Bowie took the second step of including the geology.

Let us imagine two similar mountain cones, one composed of light granite and the other of heavy volcanic rock. Hayford gives the same compensation to both, because of the similar dimensions. Bowie's modification gave a greater compensation to the heavier cone than to the lighter. I said just now that when we first applied Hayford's method in India we still found some residual discrepancies between his theory and the actual observations, but those discrepancies became greatly lessened when we followed Bowie and included the geology. To my mind, the success following Bowie's modification is a most extraordinary confirmation of the Hayford theory. In most complicated regions

we found that Hayford's method reduced our original errors by 70 per cent., and when we took the further step of differentiating between light and heavy rocks our errors were further reduced by another 20 per cent.

Captain Alessio attacks the Hayford theory on the ground that it is based upon an artifice. Let me ask this: Why has Newton's theory of gravitation been accepted? The original idea sprang from Newton's imagination, but the truth of Newton's theory has been accepted because it explained the observed motions of the planets and of the moon. It fits the observed facts.

Now take Einstein's theory. Hardly any living man can follow Einstein's mathematics, but there are certain observed facts, and the scientific world wants to know if Einstein's theory fits those facts. For example, there are the unexplained movements of the planet Mercury. Does Einstein explain them? He does. Then, again, if Einstein is correct, the stars near the sun should appear displaced when observed during an eclipse. Eclipse observations have shown that the stars are displaced in accordance with Einstein's theory, and this is considered to confirm his theory.

Hayford's theory has explained numerous observed facts hitherto unexplained all over the Earth. Surely this is the ultimate test of the truth of the theory. Captain Alessio says that Hayford's distribution is only one of many possible solutions. It may, I think, be possible to modify Hayford in minor particulars; it may be possible to make different assumptions of depth and to alter Hayford's depth by 10 or 20 kilometres, but let us keep in mind the two governing factors of the Hayford theory: firstly, that compensation is complete; and secondly, that it extends downwards to an effective resultant depth of about 25 miles. And then let us ask: Is there any other theory differing materially from Hayford's that explains the observed facts as clearly as his does? I know of none. If there is one let it be produced and tested in different parts of the world, as Hayford's theory has been tested.

Sir FRANK DYSON (Astronomer Royal): I think Sir Sidney Burrard has put the matter so strongly and so clearly that there is really very little to be said. It seems to me that in the "roots of the mountains" theory you have a suggestion which may be right but cannot be subjected to numerical test, while Hayford gives something which may only be approximately true but can be tested. Go down, say, 120 kilometres, assume a uniform density, and you have something which you can work on and arithmetically calculate the attractions. You have a perfectly simple definite hypothesis, and with it you explain the deviations of vertical north and south and east and west, and also the change in force of gravity. It is a great deal to do with one single hypothesis. I quite see the point which Captain Alessio makes about introducing a new variable and so diminishing the squares of the errors. Of course that is the case. But when you have big discrepancies of a systematic character you have to try to explain them in some way. The first thing to do is, I think, to put forward, as Hayford has done, an absolutely definite and simple hypothesis and see how it goes. The results seem to show that you have satisfied the facts by that hypothesis, and to that extent you believe in it. As to the further developments of it by Bowie, I cannot offer any criticism. I can quite see that one may be involved in considerable difficulties in trying to explain how the compensation takes place. But I cannot see that there is any getting out of the fact of compensation. Of course, if you start with this hypothesis as a basis, naturally you would not expect it to hold with mathematical exactness all the way along. You would expect it to be somewhere near the truth, and that local irregularities of smaller amount will account for the remaining 10 or 15 per cent. of the residuals. But I think

the matter has been put extremely clearly this evening, both in the paper which Mr. Bowie has sent and Captain Alessio's objections. The discussion should help us to form a clear idea on the facts of the case, and for my part I cannot see that there is anything more possible than the substantial accuracy of Hayford's hypothesis. Of course, as Sir Joseph Larmor said, and as Mr. Hinks reported, you could assume different distributions of density and get the same result, but then you are assuming more complicated conditions. Still, I take it it is only at the best an approximation that you can get, explaining the results by the most simple hypothesis that can be put forward. I do not quite see why the objection should be taken to 120 kilometres, or whatever the exact point was which Hayford took. He gets results coming up to a maximum, and he definitely works out the maximum, or the distance which gives him minimum sum of squares; he has to take something; he says that is the best thing he gets from his figures, and he takes them; no doubt there would be a great accidental error in the quantity so determined.

Dr. MORLEY DAVIES: I am a geologist, and on what is a geodetical and, to some extent, a mathematical subject I do not feel at all competent to express an opinion. But there are important geological aspects of the question, and I will venture to speak at the risk of showing my own ignorance of geodetical and mathematical matters.

When I began to read the paper by Mr. Bowie I thought I understood the meaning of isostatic compensation; but when I reached the last paragraph I began to ask myself whether I did understand it, or whether Mr. Bowie was using terms in a sense in which they were not used by Hayford. I had understood Hayford's conception of isostasy to be practically this: that if you start from the Earth's centre you can imagine the Earth as composed of a series of concentric shells, each bounded by a spheroid of rotation and each homogeneous in density, for a very great distance from the Earth's centre. At length you come to the last homogeneous shell, at about 120 kilometres below sea-level. After that the concentric shells begin to be heterogeneous in density. I understood the depth of compensation meant the depth at which you passed, from within outwards, from a homogeneous to a heterogeneous shell, and therefore I assumed that when superficial changes due to erosion and deposition are compensated by deep-seated transference of matter, that would take place within the heterogeneous layers, and that, therefore, all movements of compensation must be effected above the "depth of compensation." And now I find Mr. Bowie arguing that they take place below the depth of compensation. I can only suppose he is using the term in a different sense to that in which I have always understood it, because otherwise his statement seems a contradiction in terms. The only explanation that has occurred to me of this apparent contradiction came in the remarks of Sir Sidney Burrard, who spoke of the resultant depth of compensation being, I think, 25 kilometres. And possibly Bowie means that when he speaks of the compensating flow taking place below the depth of compensation.

The theory of isostasy was propounded first by a geologist. Of course it really originated with Pratt, but Pratt did not look at the matter from the geological point of view; he was thinking of the compensation of mountains and of oceans only with regard to the present state of the Earth. But Dutton, the American geologist, introduced the term "isostasy" and the new idea that isostatic equilibrium must have continued during geological time, and that there must be deep-seated processes at work balancing the changes in the surface; and the particular point which Dutton laid stress upon was, on the one hand,

the great accumulation of deposits in what remained shallow water in spite of those thick deposits; and, on the other hand, the apparent continuation of mountain masses at the same elevation in spite of long-continued erosion. If a basin only a few hundred feet in depth is not silted up, there must be a sinking of the bottom as sedimentation proceeds, and that sinking can take place by two processes: either by *compression* or by *displacement* of layers below. Neither of these alone will satisfy the theory of isostasy. If the sediment compresses the layer below it, then the additional mass of sediment must be added to the column, and isostasy is destroyed. If, on the other hand, it is a matter of displacement, the deep layers of the Earth's crust which are displaced are heavier than the lighter sediment which is laid down, and therefore the mass in the column is lessened and the isostatic equilibrium is again destroyed. So that we must conclude that, when there are these great thicknesses of sediment deposited, the sinking of the sea-bottom under them is effected partly by displacement of the lower layers and partly by compression. And conversely, when mountains rise in spite of long-continued denudation, the rise must be partly due to inflow of fresh material underneath, and partly to an expansion of material in the deeper layers. The two things must go together, if you are to have isostatic equilibrium maintained.

Thus we can understand how mountains are maintained in spite of erosion; and how sea depths are maintained in spite of sedimentation. But I cannot see any explanation in the theory of isostasy of the origin of upstanding masses of land or oceanic depressions.

Mr. G. W. LAMPLUGH: I can add little to what Dr. Morley Davies has said respecting the geological aspect of the matter. Dr. Morley Davies has mentioned that we have evidence over and over again, through all the geological periods, of waters remaining persistently shallow for a long time during which great thicknesses of sediment have accumulated in sinking basins. He might further have laid stress on the fact that always, sooner or later, there has come a reversal of the process, and then these masses of sediment have been heaved up. Most stratigraphers have, I suppose, vaguely held to the crude hypothesis referred to by Mr. Hinks, that the crust of the Earth is in some degree plastic; so that when sediments have been poured into a basin their weight has pressed down the floor of the basin and made room for more sediments. In this way we can account for our great thicknesses of shallow-water deposits. But, if I understand the theory of isostatic compensation aright, the process, once begun, should go on continuously, and the geo-synclines and geo-anticlines, once established, should have roughly maintained their positions. Yet we always find that where those big masses of sediment have been accumulated, sooner or later they have been heaved up and now form part of the land, building up considerable portions of our continents, and often of the higher parts of our continents. Moreover, we have reason to doubt whether there are any such masses of sediment under the present great sea-basins. Something over and above the theory of isostasy seems to be required to explain the heaving up of the weighted areas. The idea of compensation could, I suppose, be called in by the glacial geologist to account for the pressing down of the Earth's crust by the accumulation of ice-sheets in the glacial period. We find evidence in many places of temporary depression—or, at any rate, of a higher sea-level—round the circumference of the area we know to have been covered by ice-sheets; and also evidence that the land has risen again as the ice melted away, as if there was some resilience in the sub-crust. Probably the most usual, though loosely held, geological conception of the sub-crust is that we have under us a

more or less yielding foundation that gives temporarily to the weight but does not remain fixed.

But if rapid and perfect compensation has taken place under a sedimentary basin, I should have thought that it would tend to fix the basin once initiated, and similarly to fix the rising tracts undergoing denudation.

Stratigraphical geologists will continue to listen with extreme interest to the results of these researches which go so much deeper than they can ever hope to penetrate by observation, and will be ready to test them wherever possible by reference to the stratigraphical record.

Mr. R. D. OLDHAM: Listening to this discussion, as also in printed discussions that have gone before, it has seemed to me that there is a great deal of confusion and some inexact thought regarding the meaning of isostasy and the distinction between it and compensation. The word "compensation" was invented by Archdeacon Pratt to express the idea that the attraction of the visible protuberances of the Earth's surface is compensated underground by a corresponding variation in density. That is a definite thing which can be measured and computed, and it is a part of geodesy to verify this and to determine the distribution of the compensation.

Afterwards Major Dutton, in order to account for the fact to which Pratt gave the name of compensation, appealed to a first principle, to which he gave the name of Isostasy, that in any column of matter reaching vertically downwards from the surface to the centre of the Earth, the mass or weight must always be the same, and that if this equality is disturbed there is an inevitable tendency to restore it. Seeing, then, that there is continual transfer of matter from one region to another on the surface by denudation and deposition, he concluded that there must be in some way or other a corresponding transfer down below, in order to maintain equality of weight in the different columns. This concept has been followed up and developed by Bailey Willis and also by Hayford, and the reverse current of matter in later years has got the name of under-tow. But compensation has been accounted for in other ways; Osborne Fisher pointed out one, and within the last few years Dr. Fermor has shown quite another way in which compensation might be accounted for without any such under-tow.

Fisher's interpretation was frankly one of flotation, and would produce a result which, in effect, is equivalent to isostasy so far as each of the larger surface features, taken as a whole, is concerned, and it would not only permit, but even necessitate, considerable local departure from exact compensation, as calculated by the method used by Messrs. Hayford and Bowie. Archdeacon Pratt adopted a very different explanation; he regarded the underground differences in density as the primary phenomenon, and the mountain range as the expression on the surface of that expansion by which the lesser density underground was produced. In his day the only cause to which he could appeal was a change of temperature, but in recent years Dr. Fermor has shown that changes of a very different character are accompanied by variations in volume on a much larger scale than could be produced by any admissible variation of temperature, and sufficiently ample to account for the differences of surface level.

Neither of these two explanations of the origin of the surface inequalities and their compensation, by flotation or tumefaction, demands any principle or process of nature which is not fully established, and to this extent I am in sympathy with Captain Alessio's doubts of the reality of isostasy. Compensation seems to be well established and, on the average, is probably complete,

but we may at least doubt whether its explanation needs any new and somewhat metaphysical concept, such as was implied by the original definition of isostasy.

It might be said that this distinction is purely academic, but I think it is an important one, and that a clear separation of the two ideas would be useful. Nor need we go further for an illustration than what has happened this evening. In opening this discussion Sir Sidney Burrard used the expression "the Hayford theory of isostasy." Now, it so happens that Mr. Hayford has propounded what is distinctly a theory of isostasy in the sense that Dutton used it, and I would understand it; a theory, that is to say, to account for the transfer of matter underground, which is required by the transfer above ground, if isostasy is to be maintained. But the substance of what Sir Sidney Burrard said shows that he did not refer to this, but to what I should call a method, an artifice or an assumption, of calculation: the assumption, namely, that in any one of the artificial compartments into which the Earth's surface is divided for the purpose of computation, the excess or deficiency of visible mass is exactly compensated underground, and that the distribution of the compensation is similar in every compartment. This is the principle on which Archdeacon Pratt worked. Like his successor, he made use of compartments; he assumed that the compensation was similarly distributed in each of his compartments, and he investigated more than one possible distribution. That Mr. Hayford introduced a much-improved method, by which the labour of computation is greatly reduced, is undoubted, but the underlying principles and assumptions are the same, and so far as my reading has gone, I have found that in German literature on this subject the thing which Sir Sidney Burrard referred to as the Hayford theory of isostasy is uniformly referred to as Pratt's assumption.

This seems to show that it would be well if a clear distinction was drawn between the numerical quantity which can be computed as compensation, and the theories by which that compensation can be accounted for, of which isostasy, as originally defined by Major Dutton, is only one. In other words, that the distinction should be made between what can be observed and measured and what can only be inference or speculation.

The PRESIDENT: We have now heard the geological point of view. Perhaps it would be fair for the geodesists to have another speaker, so I will ask Sir Charles Close if he will say a word or two.

Sir CHARLES CLOSE: I think Mr. Hinks put the abstract very clearly before us. In fact, I learned a good deal more from his explanation of the abstract than I did by reading the abstract myself. It seems to me that what Mr. Bowie has done is to give us an extra degree of freedom. I do not see why we should not accept that freedom. We seem to be approaching the flotation hypothesis. He has given us freedom in one other respect, and that is in the not too rigid theory that the compensation occurs vertically in a column directly below the mountain peak. I happened to be looking the other day at some old observations taken in the Isle of Wight that bear a little on this point. There were four stations near Ventnor: Boniface, Dunnose, Week Down, and High Port Cliff; they are all in a circle of less than a mile radius, but though they are all in that small circle they differ very greatly in height, the highest point being 784 feet and the lowest 130 feet. There is a difference of 650 feet. It is a uniform formation—I speak under correction—of chalk, and Clarke calculated the attractions due to the topography. If you subtract the deflections due to the topography from the deflections actually found, you get a very remarkable uniformity. Those four stations which differed so remarkably in height, all on this chalk down, one right on the side of the down, one on the top, another

overlooking a valley: when you subtract the calculated deflections, which I must admit only extended to 12 miles, you get these differences from the mean: +0·4; −0·1; −0·2; +0·1 of a second. That is only one example; we have not many, but it seems to me to tend to show that the compensation is distributed to a large extent horizontally. If anybody says some of those deflections are due to errors in the original station, I say, "Yes, but they affect all those stations equally." Or if you say they are due to the figure adopted, that also affects the stations equally, and if you took Clarke's compensation beyond the 12 miles that he actually took it for, up to the 2564 that Hayford took, after the ring which represented the first 12 miles, you would find all four stations were affected very much in the same way. Personally, I think there is every reason to suppose that we must not limit too severely the horizontal area of the columns under which compensation is effected. I believe myself that the tendency is to modify the rigid Hayford hypothesis, as I think Mr. Hinks indicated.

Colonel CROSTHWAIT: When Sir Sidney Burrard was Superintendent of the Trigonometrical Survey, just after Mr. Hayford applied his method to America, he determined to apply it to India, and I was the instrument which he used, so that I was only the machine which worked it, and I had very little to do with it otherwise. But I can warn any one who wishes to undertake a scheme of this kind that notwithstanding Mr. Hayford's simplification of the method, it is an extremely laborious process. We applied it to 102 latitude stations and to 18 longitude stations; it took a very long time to do, and it meant consulting a great many maps and considerable difficulty in arriving at the mean heights of the compartments, because when you got away into Central Asia and Arabia, there were very few heights and maps were probably inaccurate in many respects.

There was one thing that struck me as regards the difference between India and the United States. In the report which was issued afterwards we put a little table in, comparing the mean residuals, and if you look at the United States' residuals you will find that from the east towards the west they all have the same sign—the minus in this case—and they all increase gradually towards the west; whereas if you take the mean residuals of India from the south towards the mountains you will find that they do not increase in the same gradual way at all, and they change sign on the way up. The United States divided their area into groups, and in India we divided ours also into groups, and the residuals I speak of are the means of these groups. These are the tables to which I refer:

U.S.A.

Group S.E.	mean residual	... ...	−0·74″
,, N.E.	,,	... ...	−0·04″
,, Central	,,	... ...	−1·66″
,, W.	,,	... ...	−4·02″

INDIA.

Region Himalaya Mountains	mean residual	... ...	−16″
Plains at foot of mountains	,,	... ...	− 2″
N.E.	,,	... ...	+ 8″
Central	,,	... ...	+ 5″
N.W.	,,	... ...	+ 4″
W.	,,	... ...	− 3″
E.	,,	... ...	− 2″
S.	,,	... ...	+ 1″

I do not think, with Sir Sidney Burrard present, I can say anything more, as he is a past-master of this subject.

Dr. J. W. EVANS: I agree with what Sir Sidney Burrard and the Astronomer Royal have said as to the way in which the observations of Mr. Bowie confirm those of Mr. Hayford. The fact that a different method has been employed renders the confirmation all the more important. That employed by Mr. Bowie was the determination of the force of gravitation. It is to some extent independent of the distribution of the heavy and light materials in the column below the point where the observation is taken. So that the result is approximately the same if there is an extended layer of high specific gravity close to the surface or at a depth, we will say, of 20 or 50 miles. Whereas in the case of observations of the deflection of the plumb-line the effect of heavy materials diminishes rapidly as the depth increases. Possibly a comparison of the two methods will enable us to ascertain to some extent what is the distribution of the heavy and light material in a column. Perhaps we may bring in to assist us observations by means of the Eötvös balance, which would of course, give similar results to those obtained from the deflection of gravity.

We have had a very interesting discussion as to the origin of the variations in the level of the Earth's surface which require compensation in order to maintain isostasy. Personally I have no difficulty in realizing what must be the course of events. If we suppose that isostasy were perfectly established at any particular moment there would immediately be forces operating to disturb that isostasy. These are not only the forces due to the deposition of material in the shallow seas or plains, the accumulation of ice near the poles, or the removal of materials from the mountains by erosion. All these, it is true, affect isostasy and require compensation, but there are other causes which tend to disturb isostasy, and those are the movements due to lateral pressure or tension on the crust of the Earth. If compression produces important folding, there must be an accumulation of the lighter crust of the Earth at particular places, which will build up mountain masses. But the height of these will be reduced by the simultaneous operation of the principle of compensation, for the weight of the folded mass will cause a depression of the heavier zones below. Again, if as the result of tension in the Earth's crust, whatever the cause of that may be, there is drifting apart of continental masses, there will be a region where there is less mass than elsewhere, and consequently a rise of the heavy zones below it. These changes disturb isostasy, as much as the sub-aerial phenomena of erosion and accumulation. To restore isostatic adjustment an underground flow of material takes place. It may be argued that the Earth is so rigid that it is impossible to understand such a flow. The answer to that is that where great periods of time are involved the Earth may be regarded as fluid, although, as earthquake vibrations tell us, for very minute spaces of time it is practically rigid.

I certainly agree with Dr. Morley Davies' objection to Mr. Bowie's statement that the flow is below the level of compensation. I have grave doubts, however, as to whether the level of compensation is as deep as Mr. Hayford supposes, and it is a legitimate criticism of his work that the calculations betray such a very slight difference between the results of the level of compensation being at depths of 60 or of 120 miles, that they cannot be used as an argument to show at what depth the compensation occurs. But at the same time, like Dr. Morley Davies, I believe that the flow probably occurs at very moderate depths and certainly above the level of complete compensation.

In this country, and in most parts of the British Empire, we are far behind

India and the United States in the study of the variation of gravitational force, and I must wish that steps will be taken to rectify this. A committee of the British Association has been appointed for the purpose of considering what can be done, and I hope that something will come of it, because it is impossible to exaggerate the importance of the question or the interesting results to which a study of it may lead.

The PRESIDENT: We have had a very interesting and, I think, fruitful discussion upon this somewhat technical subject, and for that we are largely indebted, I think, to the lucidity with which Mr. Hinks has summed up the arguments put forward in favour of the theory of isostasy by Mr. Bowie and the main criticisms of that theory which have been made by Captain Alessio. I am sure the meeting would desire me to express its gratitude to the Secretary for the amount of time and trouble which he has taken in placing this matter before us.

Dr. HAROLD JEFFREYS (in a written communication) says: The work of the United States Coast and Geodetic Survey in putting the theory of isostasy upon its present basis is one of the outstanding scientific achievements of our time. The success of the Hayford hypothesis in accounting for the gravity anomalies in the United States and Canada provides theoretical geophysicists with one of their hardest problems; by its success in accounting for the facts collected so carefully and marshalled so skilfully by Hayford and Bowie any theory of the nature of the interior of the Earth must be judged. I have little to offer in comment on Dr. Bowie's paper, with almost all of which I agree. I doubt the suggestion that mountains are best regarded as formed to compensate deficiencies of density below them. Presumably, however mountains were formed, the weak matter below them would accommodate itself at least as fast as was necessary to maintain compensation; thus for all practical purposes the deficiency of density below would develop at the same time as the mountains, both as incidental effects of the same process. Denudation, however, certainly starts at the surface, and the fact that denudation valleys are compensated shows that in some cases at any rate compensation below is stimulated by changes near the surface.

I feel sceptical about the conclusion in section 3 that the depth where flow takes place is to be measured in tens rather than hundreds of miles. In the last paragraph it is stated that this level must be below the layer of compensation—*i.e.* below 100 kilometres. With the latter statement I agree.

Captain Alessio's paper is based on a complete misconception of the nature of scientific method. The problem of science is to co-ordinate a large number of data in terms of a comparatively small number of laws; the test of a hypothesis is its success in co-ordinating our knowledge. It is of course true, as Captain Alessio says in paragraph 2, that the residuals in gravity could be explained completely in an infinite number of ways by hypothetical distributions of density. If, for instance, we know the three components of gravity at each of n points, we have $3n$ data. If then we chose arbitrarily any $3n$ points inside the Earth, it would be possible to find masses such that when placed at these points they would give just the actual components of gravity. But all this shows is that a number of facts may be co-ordinated in terms of an equal number of hypotheses; it is like explaining the motion of a falling body by saying that a new body has been created at the instant of every observation. The point of the law of uniform acceleration is that it explains more than it assumes; and this is just precisely what the hypothesis of isostasy does.

Again, it is true that the introduction of only one unknown can in general be made to lead to a reduction of the residuals, whether it corresponds to a law or not. But in the absence of a law connecting the observations the reduction would be only a small fraction of the mean residual: Bowie shows that the Hayford hypothesis reduces the mean residual to a seventh of its original value. The argument may be expressed in another way. On every mountain-top it is found that the Bouguer hypothesis of no compensation gives too great a value of gravity, while the Helmert hypothesis of no compensation at zero depth gives too small a value of gravity. The Helmert anomaly is about half as great as the Bouguer anomaly, and with the opposite sign. Accordingly it is certain that complete compensation at some depth in the crust will account exactly for the anomalies. But what is of special interest is that so good an agreement is obtained by supposing this depth to be the same below all mountains.

The comparison of the hypothesis of isostasy with that of densities of 0·3 for the land and 2·5 for the sea shows a further misunderstanding of the problem. What we have to do is to account for the gravity variation over the surface of the Earth in the light of our existing knowledge. We know that these densities are ridiculous; and it is of no interest whatever that we can account for the gravity variation on a hypothesis that we already know to be false. The hypothesis of isostasy accounts for the facts without introducing anything unplausible, and therefore has a high probability on the basis of our actual knowledge.

ACROSS ERITREA

Major H. C. Maydon

IN November 1922 three of us landed at Port Sudan, and travelling by rail and motor to Tokar *viâ* Suakin, there fitted up a camel caravan for four months' safaria. Our object was thoroughly to explore Eritrea for the Abyssinian ibex, or Wala, first shot by Major Powell Cotton some years ago; or failing that, to try and find a link between it and the Nubian ibex of the Red Sea hills of the Anglo-Egyptian Sudan. Doubting the possibility of getting further than Eritrea in the time, we omitted to apply for an Abyssinian permit beforehand. While waiting for our permit to enter Eritrea we spent the first month hunting in the southern part of the Red Sea hills. A few words of description of this country are necessary, for comparison with Eritrea which borders it.

Thirty miles south of Tokar we entered a region of barren foothills, which gradually expanded and grew bigger as we moved south. The general formation of this group of mountains is T-shaped, the tail of the T represented by several chains of hills running north and south, separated by deep ravines. These hills, starting at 300 or 400 feet, rapidly grow to about 3000 feet, broken by isolated peaks of 5000 to 6000 feet, and culminate in the much loftier range which forms the head of the T, which runs roughly east and west for 50 miles, and forms a natural barrier between the Sudan and Eritrea. About the centre, on the Eritrean side, is the small elevated plateau of Hagar Nush, 9000 feet.

We trekked up the deep sandy-bedded Khor Sharag which follows the tail of the T, until the going was too bad for camels. Water was scarce and found only in holes in the sandy bed at long marches apart. Local inhabitants, of the Beni 'Amer tribe, were rare and nomadic owing to water conditions. Nubian ibex were seen daily in the hills, and Isabella gazelle in the wadi bed.

We now retraced our steps a day's march, and striking westwards crossed a very steep pass, Abu Khamsa, and dropped into the broad sandy valley of the Baraka. This is a flat plain some 30 miles broad, with smaller hills beyond to the west. The Baraka, which runs down to the sea near Tokar, is dry most of the year, but has water holes and pools at irregular intervals, and the natives in places raise scanty patches of durra.

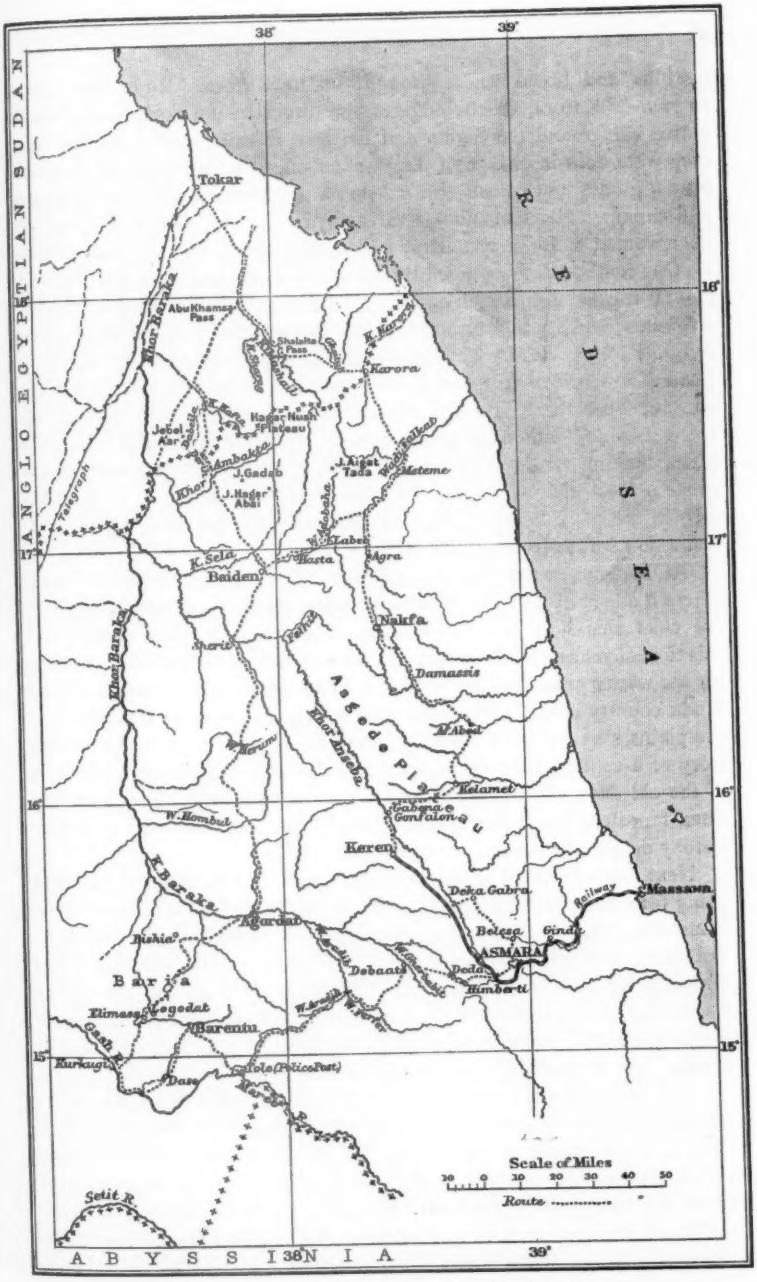
We followed the Baraka to its junction with the Khor Ambakta, on the north-west frontier of Eritrea. Near here, in Khor Hafta at the foot of the mountains, we found a small isolated group of *Oryx Beisa*, and succeeded in bagging a couple. This was interesting, as we had heard rumours of them, but nothing authentic, nor could we hear of any one who had shot them here before. We had great difficulty in finding them, and only one Arab could guide us to their haunts. In fourteen days' hunting each of us saw one small herd only. We finally made almost a complete circle round them and found no more here. Close search and inquiries for them later in Eritrea gave no result.

We now received our permit to enter and shoot in Eritrea. On the advice of our Arab guides, who said that all other routes were impracticable, we decided to make for Karora on the eastern side of the mountains which form the tail of the T.

Recrossing the Abu Khamsa pass we followed the Khor Sharag to its junction with the Khor Mashail, where we then turned south-south-east. In the Mashail some very fine Nubian ibex were bagged, including two over 44 inches. Judging by those shot and heads picked up, the average seemed to be about 40 inches, and they were more massive than heads shot further north. This added to our hopes of finding either the Wala itself, or a link between the two, across the border.

We now followed up the Khor Mashail, which slowly climbed and dwindled, and we finally crossed the easy pass of Shalalta. The change at the top of the pass was curious. Behind us westward was a barren sterile country, practically waterless and uninhabited. Before us eastward was a fairly thickly wooded country of grass and green leaves. Water was more frequent, and there were even occasional running streams. Natives with their herds of goats, sheep, and cattle were everywhere. The chain of hills which the Shalalta pass crosses is the barrier between the mists and almost daily winter rains of the littoral and the arid desert of the hinterland.

Leaving Gheitub away to the east, three easy days' marching through



Sketch-map of Eritrea to illustrate Major Maydon's Journey.

foothills and broad wadis brought us to Karora. Kudu were seen *en route*. Karora, on the edge of the littoral plain, comprises a small native village and the Sudan and Eritrean frontier posts. At this date they were both in charge of Arab under-officers. We paid off here our Sudan guides and camels and enlisted a new caravan of Eritrean Arabs and camels. News of our arrival had preceded us, and both here and after we met with every courtesy and assistance from the Italian officials.

Our route was now guided by the quest of two animals : the Eritrean ibex, if it existed, in which case we intended to trace them south towards Abyssinia, and see if they assumed the characteristics of the Wala ; and secondly *Oryx beisa*. Failing to obtain any reliable information at Karora we decided to make for the mountains, 30 miles south-west of Karora, and there try for local information. We left Karora on December 28, and skirting some small foothills crossed a flat open plain, making for Meteme on the wadi Falkat. The nomadic Arabs spoke a local dialect, but most of them understood Arabic. The game seen in the plain included Isabella gazelle, Ariel, guinea-fowl, bustard, and a new sort of francolin.

At Meteme, which was a temporary village in the bed of the wadi where it emerged from the hills, we met the Nazr Muhammad Kantebai, the chief sheikh of the neighbourhood and a big camel owner. At this time of year all his followers and their camels had collected at Meteme for the winter grazing of the littoral. From his people we heard of good Kudu country ahead—*i.e.* south—and a vague rumour of *Oryx beisa* in the plains westward ; of Ibex there was no news. There was a strange story of a solitary herd of elephant in Jebel Aigat Tada, sole survivors of the old days when game swarmed over the country. This yarn was often repeated, but it hardly seems likely that elephant should live on a stony desolate mountain some 7000 feet high.

Next day we pushed on up the Falkat wadi into the mountains. The going for camels was easy, up a broad sandy wadi shut in by ever-rising mountains, with a running stream of water too brackish to be palatable. But every few miles were water-holes of good clear drinking-water. Although we were mounting all the time from Meteme, and the climate was cooler than the Sudan, there was always more vegetation than in the Sudan hills. We were now on the northern slopes of the Abyssinian plateau, which runs right up through Eritrea from south to north.

The track up the wadi Falkat is the direct route from Karora to Nakfa, the northernmost strong-post of Eritrea, and equivalent to a merkaz or civil station in the Sudan. There was still a disused telephone wire from Nakfa to Meteme, and isolated police posts in the mountains along the route. Just short of Agra and 20 miles short of Nakfa we made a three-day camp to hunt Kudu. The mean altitude must have been 3000 feet, and the surrounding mountains were not much higher. Already the country had begun to rise in steps, with small plateaux

THE KHOR MASHAIL, RED SEA HILLS

KEREN

ABU KHAMSA PASS

THORNBUSH IN THE LOWLANDS

DOM PALMS ALONG THE GASH RIVER

much broken by side ravines. On foot one could have gone across country almost anywhere. There were no fixed villages or sedentary inhabitants, but small parties of Arabs and their herds passed us daily.

As a Kudu country it was wonderful: hereabouts they went in herds up to twenty. It seemed their habit to wander and graze in the wadis and along the grassy banks and small plateaux by night, and to retire to the ridges and smaller hills by day. We bagged a fair head each in two days. One morning I counted four herds, all on one small plateau scarcely a mile square. They were so common and so tame that we despised them, little recking that we should never have such a chance again. Warthog and Salt's Dikdik were common, and there were a few Klipspringer. Meantime we had pressed our inquiries for Beisa, and from a wayfaring Arab heard a likely rumour of them down toward the Sela plain, 50 miles westward. As this was due south of and almost linked to the spot where we had found them in the Sudan, we were very hopeful.

From wadi Falkat we struck almost due west and crossing a small pass dropped sharply down into the wadi Adobaha, and thence *viâ* Labeb and Hasta to Baiden on the eastern edge of the Sela plain. From Adobaha onwards we were in the low hot country again, bounded by the high mountains of the northern frontier (head of T) to the north and the Abyssinian plateau to the east. We were now among sandy barren foothills, and water was scarce. We met many Arab caravans loaded with durra, marching from the Baraka to the littoral. At Baiden, the only important place in this district, was the large village of a merchant sheikh, rich in camels, who did much durra-convoy work. We won his heart by a little primitive doctoring of his sick son, and he sent camel-men in all directions to hunt for news of Beisa, but without result.

From Baiden we crossed the Sela plain southward to Sherit, on the wadi Anseba, where we met another powerful camel sheikh, and were as usual hospitably received. Thence we followed the main inland track to Agordat, about 130 miles south of Baiden by the wadis Herum, Hombul, and Hal Hal. This route was little used except by migratory Arabs, but water from holes or wells in the river-bed was found every 15 or 20 miles. Isabella and Ariel gazelle were seen and an occasional Kudu, while black partridge, sandgrouse, Obara, and guinea-fowl were very common. The big wadis were full of very dense tamarisk thickets, otherwise trees were scanty. The country was much broken by barren foothills and rocky ravines, but it was fair going for camels.

As we moved further south the country changed and grew much flatter, with isolated hills and large plains of dry coarse grass. It much resembled Kordofan in places, and Tebeldi trees were common. There were many varieties of humming-birds which I have never seen inland. There was no rain in this part in the winter, though very heavy mists swept down from the mountains and often shrouded the country till

DOM PALMS ALONG THE GASH RIVER
THORNBUSH IN THE LOWLANDS
ABU KHAMSA PASS

10 a.m. It was very hot between 11 a.m. and 4 p.m., with damp stuffy nights and a heavy dew.

On February 12, after trekking about 250 miles since leaving Karora, we sighted Agordat on the other side of a broad grassy plain. It is built on low foothills on the south bank of the Baraka wadi, and the white walls of the Government buildings are conspicuous for many miles.

The Baraka wadi, after running nearly 200 miles almost due south from Tokar and parallel to the western boundary of Eritrea, here turns eastward by Agordat and disappears among the mountains below Asmara. In the Sudan it had been a mere sandy depression in the desert, with a few scattered thorn trees. Here it was full of stately Dom palms and the dense shade of tamarisk trees, with islands of long thick grass and dense scrub. But, as usual, there was no running water. There was a pumping station to supply Agordat, and the natives had wells dug in the bed.

We were most hospitably received by the Commissary at Agordat, who gave us rooms in the official rest-house. The Government buildings are very fine, though there are only about twelve white officials there and a small post of native troops. There is a motor road to Keren on an extension of the Asmara–Massawa railway, and of course a telegraph, besides a telephone to most outlying police posts. We were particularly struck by the roads and the telephonic communications. In this south-western area of Eritrea they have main roads cut through bush and over mountains, and no doubt kept up in part by enforced local native labour, while all the small isolated police posts seem to be linked up to head-quarters by telephone.

At Agordat we could get no news of *Beisa* and less of Ibex, though some of the officials there had seen Abyssinian Ibex horns brought in by traders from Abyssinia. The Commissary—ranking with the governor of a province in the Sudan—advised us to go south to the Gash river for possible lion and game of all sorts, but he warned us that we were not allowed to shoot in the area contained by the Gash and Setit rivers, which is a game reserve by international treaty. We now despaired of finding *Beisa* again, but decided to explore to the Gash and along it eastward, and thence up into the mountains towards Asmara. The Semien mountains are only 180 miles south of the Gash, and we hoped to find Ibex on the mountains directly north of that river.

From Agordat to Kurkugi *viâ* Bishia and Logodat (70 miles) is through very dull country of flat grassy plains, isolated foothills, and wooded wadi beds. There are many villages of the Baria tribe, who speak a local dialect of their own, and were a distinct change for the worse after the more courteous and friendly tribes of northern Eritrea. As always, during our trek through Eritrea we had two native police attached to us as guides and helpers, who from Agordat onwards were changed at each post. After Agordat these men were generally

Abyssinian, and neither in manners nor intelligence ever matched their more Arab *confrères*.

About this time the Isabella gazelle disappeared entirely, and was replaced by the Heuglin gazelle. The difference is slight, but the reappearance of the dark lateral flank band, as in the Dorcas and absent in the Isabella, and the distinct shape of the horns, establish a clear distinction. There was no apparent reason for the sudden change.

The last 12 miles from Eimasa to the Gash is through a belt of very thick thorn scrub, which would have been quite impenetrable had it not been for an old disused Government road cut through the scrub. This thorn belt runs right through to the north bank of the Gash and follows it as far as we went. The Gash itself was by far the biggest river-bed we had seen, and as usual bone dry. There were water-holes dug in its bed every 10 to 15 miles, about 6 feet deep, and Baria villages near by. Cattle and goats were grazing along the banks, as the grass was good. The Gash river-bed was a highway for numerous camel caravans moving east and west from and to Kassala and the Eritrean interior.

Abyssinian Oribi and leopards were seen; otherwise game was scarce save a few Heuglin and an occasional Kudu. It was unpromising game country, owing to the thorn belt and the number of villages and wayfarers. A thick fringe of Dom palms and tamarisk trees lined the river-banks. After 30 fruitless miles of the Gash we struck north to Barentu *viâ* Dase, making use of another old Government road through the thorn belt.

Barentu is another small Italian out-station and military post on the edge of the thorn scrub and still in the low desert country. We here met an Italian Survey party *en route* for the Gash. They told us that they believed it was possible to find a direct route to Asmara across the mountains, but no guides who knew it were forthcoming. However, as we wished to see new country we set forth with two very stupid native police guides. This turned out to be by far the most arduous part of the whole journey, and with camel transport not lightly to be undertaken. Our maps were bad and on too small a scale, while the Italian rendering of the names made them difficult to reconcile with the colloquial. At the mercy of our guides and the rare tracks in the thorn scrub, we found ourselves being slowly pushed south towards the Gash—which here is called the Mareb—and the Abyssinian frontier. At last we reached a police post at Tole, whose native N.C.O. seemed much alarmed at our approaching the frontier, and held us up while he consulted Barentu by telephone. To our relief he was instructed to find us guides northwards towards Asmara. We were anxious to reach the mountains again and to be quit of the dull low country of thorn bush and small foothills. There were a good number of native inhabitants hereabouts, with some permanent villages. But they were mainly of the Baria

tribe—ignorant and unhelpful—with a sprinkling of Abyssinians from the south and Beni 'Amer Arabs from the Baraka country. The Baria natives, either from ignorance or laziness, never seemed to know the way anywhere, and we were surprised at the ignorance shown by the native police of the isolated posts. However, by bribes and threats we at last persuaded two Beni 'Amer goatherds to guide us as far as the next water in the wadi Ferfer.

On the first two marches north of Tole we passed many native villages and patches of durra on the edge of a broken plain to the east. The going was fair, through foothills and thorn scrub; but after 15 miles the country became more broken and hilly, and we passed the last police post, on the heights above a deep stony ravine with pools of water and poor shade. The N.C.O. of the post did his best to turn us back, telling us he did not know the track ahead, where was neither good road nor water. Our map was now useless. The Ferfer was not even marked, and the few names shown were unknown to the natives. We could carry enough water for two days in our fantasses, and not wanting all our trouble in vain, we decided to push on.

We left the deep ravine in the evening and followed a vague track through rather thick bush till dark, when the track seemed to fade away. Our camel-men and guides were much disturbed with ideas of being lost and of robbers.

We were off before dawn, not on a path, but following a hazy clearing through the bush, probably the line of an old path. The going was very bad for camels, and we marched mainly on foot. At midday the bush thinned, and we emerged on the slopes of a big hill. In front of us the country sloped down to a large open plain, with lofty mountains in the distance. This plain proved another obstacle, as it was cracked black cotton soil, covered by long grass and difficult for camels. We reached the Aradib wadi at dark, and next day followed it down to the Ferfer. This must be the wadi shown on our map as the Sciagulgul. From here our difficulties were at an end. The Ferfer is the usual broad sandy wadi winding its way through foothills and thorn bush. There is plenty of surface water, and the bed of the wadi is used as a camel caravan route between the Abyssinian border and the Baraka country round Agordat.

From a police post at the junction of the Ferfer and Todhi wadis we got guides, and steadily climbing, pushed on north-east over a broad elevated plateau to Dobaate. This plateau is some 20 miles broad, shut in by mountains. It is grass covered, with patches of bush. Many Heuglin's gazelle and some Kudu were seen, but there was no water.

From Dobaate the path follows the wadi Gherbabit straight up into the mountains. Five short marches, difficult for camels, brought us to the top of the plateau on which Asmara is situated. The last 10 miles were all steady climbing, and we estimated that we had mounted some 5000 feet

NEARING THE ASMARA PLATEAU

SUMMIT OF THE ASMARA PLATEAU

ASMARA

THE BARRIER BETWEEN MOIST AND DRY COUNTRY, RED SEA HILLS

THE BED OF THE GASH RIVER

SHALALTA PASS

from Dobaate. We passed many villages *en route*, all Abyssinian. There was no sign of game. This route passes Deda village a few miles north of Himberti. The mountains, although higher than the Sudan hills, are not so rugged and are much more fertile. They are covered with coarse grass, patches of bush, and wild cactus. Water, though rare, is enough to support the villagers and their herds.

The Asmara plateau is some 20 miles broad from west to east, and is flat and dull in the extreme, with an utter lack of trees and vegetation. There are occasional Abyssinian villages, generally perched on small hilltops surrounded by dry patches of cultivation. Water for irrigation is scarce. A long day's march across the plateau brought us to Asmara. As it is built in the plain you come on it suddenly, as one arrives at a town on the high veldt of South Africa. All at once and point blank, you see groups and avenues of trees with glimpses of white houses scattered among them. At one end is an isolated kopje crowned by a few military buildings.

West and east, to Keren and Massawa, runs the railway across the flat treeless plain. Ten minutes later you are riding through straggling, rather pretty villas, surrounded by trees. A rough road leads direct to the centre of the European quarter, with several metalled streets, running parallel to one another, lined with quite good buildings and Italian shops and cafes. The post office, banks, and theatre are all exceptionally fine buildings. North of the town are the palace of the Governor, Government offices, and officers' club, all first rate. At the other end of the town is the native bazaar and Indian quarter, and outside lies the Abyssinian quarter, almost a town of its own. We were told there are 5000 white inhabitants. The native population is mainly Abyssinian, but is very cosmopolitan. Italian is generally spoken by the more civilized natives, but Arabic is useful. Lira coinage, both notes and nickel, is in circulation, and happily still maintains some semblance of its old market value, so that Eritrea is a very cheap country to live in. The climate on the plateau in winter is excellent: there are very cold nights, and it keeps cool till midday. The town is lit by electric light, and the sanitation seemed good. We put up at one of the only possible hotels, which was clean and good, but the food at the restaurant across the way was very poor, until we introduced our own cook. Most stores and other things could be purchased.

We applied by telegraph for a permit to enter Abyssinia, and while awaiting a reply made two short local trips in search of game. Ten miles east of Asmara the plateau ends and drops abruptly in steps towards the littoral. We went *viâ* Belesa, passing several large reservoirs *en route*, from which Asmara is supplied with water. Beyond Belesa, which is on the edge of the plateau, is another reservoir, fed from the others, from which a pipe line drops sharply down to Dorfu power-station, 3000 feet below, with hydro-electric installation for supplying Asmara

with electricity. We followed a steep winding path to the power-station, and found ourselves in a broad fertile valley shut in by mountains, and much resembling a Kashmir valley in miniature. The climate was cool, but almost semi-tropical. The hillsides were heavily wooded with small trees and bush. There were several Italian farms down the valley, growing bananas, oranges, guavas, and vegetables, and a clear running stream, with shady trees along the banks. A damp heavy mist drifted up from the sea nearly every day. Despite the farms, and many Abyssinian villages, we spent a very pleasant week following this valley down to Ginda, on the Massawa railway, and had quite fair sport with Klipspringer, Abyssinian duiker, and a very large variety of mountain francolin, called pheasant by the Italians.

The second trip was to Deka Gabra, beyond the northern edge of the high plateau, 30 miles north of Asmara, and east of the Keren railway. The plateau narrows here considerably, dropping abruptly some 3000 feet north and east in steps, towards the littoral. Westward it drops less steeply to the valley of the Anseba, along which runs the railway to the Keren depression. A dense white blanket of mist generally hid the country seawards. After dropping 1000 feet one entered the region of trees and vegetation. Deka Gabra is on the first step, 3000 feet down, a cup in the lower mountains, from which many wadis and deep ravines start to the sea. There is plenty of running water, and the country seemed fertile, but there are only a few scattered native villages. There were a few very wild Kudu up in the mountains, which we vainly hoped might prove to be Mountain Nyala.

Despairing of our Abyssinian permit by now, we decided to return to the Sudan from Asmara by another route. We took train to Keren, and thence with camel transport again proceeded to Nakfa *viâ* Gabena Gonfalon, Kelamet, Af Abed, and Damassis. This route led us along the Rore or northern continuation of the Abyssinian plateau (called on our map the Asgede plateau), much narrower and probably 2000 feet lower than the Asmara or Hamasen plateau. It drops less steeply to the valley of the Anseba on the west, and to the littoral on the east. It is covered with thin bush, water is scarce, and only nomadic natives were seen, except for isolated villages at the wells.

Nakfa is almost on the northernmost edge of the Asgede plateau and comprises a native village, a strong police post, and the headquarters of a sub-governor, then on leave. From Nakfa the plateau breaks up into deep ravines separating chains of mountains dwindling down to the plains. We hunted Kudu for several days without seeing anything good, and then turning west descended from the plateau and followed the great Khor Felhit into the plain to our old camp at Baiden. Our plan was to find a new route back into the Sudan at the foot of the two big Hagar mountains, and have a last final search for *Oryx Beisa* near the frontier.

Our old friend Sheikh Muhammed Idris of Baiden did his best and found us new camels and guides who would undertake the journey. Despite the difficulties we expected, it turned out fairly simple. As the crow flies it is about 60 miles from Baiden to our old Beisa camp at Dabeila, in Khor Hafta, across the border. The first 30 miles were easy going by the wadis Sela and Mihinait. After that the track followed a stony ravine which rose sharply with much winding and turning, so that one hardly advanced 1 mile in 3. We now passed within 2 or 3 miles of the foot of Jebel Hagar Abai, and close to Jebel Gadab. Here is a huge cup or circular tree-grown space, shut in by mountains, and from which the various wadis, including Adobaha, rise and flow down to the plain. The Arabs say there are ancient Abyssinian ruins on the top of Hagar Abai, but that no one lives there now. It is 8000 feet high and has only a goat track up, so we were not tempted to explore. Thence the path began to drop, and 20 miles further brought us to the Khor Ambakta. We were quite close to the border, and in very likely looking *Beisa* country. We made careful inquiries from Arabs met, but could hear nothing about them, although they knew of Ibex close by.

The big mountains were now all behind us to the east and south, and the country though broken was no great obstacle.

At last we reluctantly abandoned the search, and following the little wadi Derih, crossed the border and reached our old Beisa camp at Dabeila, near Jebel Aar. We still had one Beisa left on our Sudan permit, but no more sign of them was seen. Thence we marched direct to Tokar.

The Foreign Office handbook of Eritrea divides the northern area, which forms the main part of the colony, into seven regions: (1) the coast zone of Massawa; (2) the eastern slopes of the Abyssinian plateau; (3) the Hamasen plateau itself; (4) the region of the Rore Asgede plateau, which continues the former to the north; (5) the eastern slopes of the Rore; (6) the valleys towards the Sudan; (7) the plains towards the Sudan. Of these we had trekked over all except numbers (1) and (5). I should be inclined to add yet another region: the mountain group, including the two Jebel Hagars, Aigat Tada, and the Hagar Nush plateau, which form the head of the T and separates Eritrea from the Sudan. This group is quite separate from the Asgede plateau, and their highest points are supposed to reach 9000 feet. The slopes are more precipitous and desolate than those of the mountains further south. There is a great variety of climate at the different heights, but at this time of year we found it healthy everywhere and little fever. The natives were friendly and willing in the north, where the camel-owning Arab element is predominant, but less so in the south in the Baria country. The Abyssinian region of the Hamasen plateau was the most thickly populated, with permanent villages generally grouped round a church, though it was hard to reconcile oneself with the idea that they were

Christians. Otherwise the natives were mainly nomadic, living by water-holes or along the trading routes.

We came across no antiquities during our travels, but much regret that we did not visit the ruins on top of Jebel Hagar Abai. We heard that a former English governor of Port Sudan had explored it many years ago and been much interested, but no information was forthcoming. I can offer no explanation of the rarity of game, considering that there is more water and better grazing than in the Sudan hills. But it is a good country to see.

THE SOUTHERN BOUNDARIES OF BRAZIL

As Fronteiras do Sul.— Fernando Nobre. São Paulo: Monteiro Lobato & Co. 1922. 8vo. Pp. 612.

THE Society has been glad to receive from Don Fernando Nobre, the Brazilian author, a copy of his recent work, of course in the Portuguese language, on the Southern Frontiers of Brazil. The opening historical sketch (pp. 1 to 391) explains how the rivalry between the Portuguese and Spanish colonists on the Atlantic side of South America resulted, after a long period of storm and stress, in the emergence of Uruguay as an independent Spanish-speaking State, lying, a kind of buffer, between Brazil and the Argentine. The concluding chapters (pp. 392 to 583) deal with the jurisdiction of the respective riverain States over the waters and islands of the River Plate.

This great bay or estuary, whatever may be its proper designation, was from the earliest times regarded by the Portuguese settlers as the southern boundary marked out for them by nature itself. De Solis, who discovered its waters in 1508, was probably a Spaniard. But the Portuguese navigator de Sousa was the first to claim possession of its shores, and he did so in the name of his king. In 1676 the episcopal see of Rio de Janeiro was recognized by the Pope as extending to the left or northern shore of the River Plate. It was felt, however, that a formal occupation was needed to clench the matter, and an expedition was accordingly despatched from Rio which selected, as the most appropriate spot, a point on the northern shore almost exactly opposite Buenos Aires, the growing Spanish stronghold on the southern shore. Here was founded, in 1680, the important Portuguese outpost of Colonia do Sacramento. The Portuguese flag was hoisted at the same time on the neighbouring island of Martin Garcia, commanding the mouths of the great rivers Paraná and Uruguay.

This was only one of the many desperate raids which about this time were being pushed by the hardy Portuguese settlers at San Paulo and other posts into the remote interior, and north and south along the coastal regions. Senhor Nobre records the achievements of some of these bold filibusters, now glorying in the name of Brazilians, and gives good reasons for his contention that Brazil was far from falling like ripe fruit into the mouths of the Portuguese colonists; that these did much more than peacefully occupy the regions assigned to them by the decision of Pope Alexander VI. and the later Treaty of Tordesilhas; and that the gigantic possessions and far-flung frontiers of Brazil were won by sheer hard fighting, and are therefore held by the most indisputable title.

Colonia remained the principal apple of discord between Rio and Buenos Aires till its final attribution to Uruguay in 1828, and in its stormy history it was frequently taken and retaken by the contending colonists. Spain, under the feeble sway of Charles II., her last King of the House of Austria, recognized its possession by Portugal. This was confirmed by the Treaty of Utrecht in 1713, but the Governor of Buenos Aires retaliated by seizing a neighbouring point, on which a few years later Montevideo was founded. The dispute dragged on. In 1750 a serious attempt was made to lay down a definite frontier between the Spanish and Portuguese possessions in those regions. Alexander de Gusman, greatest of Portuguese diplomatists, consented, in the important Treaty which he negotiated that year at Madrid, to give up Colonia, and with it the cherished claim of Portugal to the left bank of the River Plate. In return Spain ceded to Portugal the Jesuit missionary stations on the River Uruguay. Delegates were deputed to mark out the frontier by setting up marble pillars inscribed with the initials of the two Peninsular sovereigns, and with the hopeful motto "Pax et Justicia osculatæ sunt." Three of these pillars were actually planted along the line drawn in the Treaty, but further agreement proved impossible. The line started at Monte de Castillos Grandes, on the east coast not far below the present south-eastern boundary of the Brazilian Province of Rio Grande do Sul, and terminated near the confluence of the Ibicuy with the Uruguay, at a point leaving the Jesuit settlements on the Brazilian side of the frontier. The Jesuits were to be bundled out, bag and baggage.

The ruthless execution of this last provision entailed a desperate struggle, known in Brazilian history as the Jesuit or Guarani Indian war. The conflict ended only in 1756, with the surrender to the combined Brazilian and River Plate forces of the seven Jesuit missions lying along the eastern bank of the Uruguay. The Jesuits in South America receive no mercy at the hands of Senhor Nobre. He condemns in the strongest terms what he describes as their lust of domination, their rapacity, and the cruel treatment of the Indians enslaved within their reservations. He denies to them any of the civilizing virtues, and praises the enlightened policy of Pombal, who enacted humanitarian laws for the protection of the Indians, and who did so much to bring about the final suppression of the order. The subject has often been treated by other authors from a more detached standpoint, allowing the Jesuits credit for a high degree of culture and enlightenment. In the 'Cambridge Modern History,' vol. 5, chap. xxii. they are described as sheltering the Indians against cruel treatment by the colonists. But Senhor Nobre gives good grounds for his belief that Rome did make, through the Jesuits, a serious attempt to set up in South America a vast territorial empire of her own, side by side with those of Portugal and Spain.

An aggressive policy was now for many years pursued against the Portuguese by Zeballos, the first Spanish Viceroy of Buenos Aires, and the entire Province of Rio Grande do Sul was on the point of falling into the hands of this ambitious governor when in 1777, by the Treaty of San Ildefonso, the main lines of the 1750 settlement were re-enacted, and Colonia was finally withdrawn from the grasp of Brazil. It remained, however, in dispute between the patriots of Montevideo, supported by Brazil, and Buenos Aires. A new boundary Commission fixed the south-eastern extremity of Brazil on the little river Chui, where it still remains, and the peace of 1801 between Spain and Portugal gave final possession of the Rio Grande Province to Brazil.

In 1808 the Portuguese Court fled before the advancing hosts of Napoleon, taking refuge at Rio de Janeiro, which thus became the capital of a European State. The Regent, soon after his accession to the throne in 1816, styled himself King of Portugal, Brazil, and the Algarves. Brazil thus acquired an importance at least equal to that which had accrued to the provinces of the River Plate by the establishment of the Vice-Royalty at Buenos Aires in 1776. The Spanish-speaking provinces of the River Plate and the Portuguese-speaking States of Brazil lay side by side, both imbued with the same monarchical spirit, and with a still ill-defined and fluctuating frontier lying between them.

When Napoleon placed his brother Joseph on the throne of Spain and carried off the Spanish Royal Family to France, the allegiance of the Spanish colonists to their captive sovereign began to waver, and the first patriots of the independence movement took up an attitude which had to be reckoned with. The expulsion of the British forces under General Whitelocke from Buenos Aires and Montevideo, without assistance from the mother country, had given confidence in their own powers to the colonials. Long years of misgovernment, rendered intolerable by the restrictions of the exclusive Spanish mercantile system, had indeed well prepared the ground for a revolutionary effort. Senhor Nobre shows how inevitable the crisis was. In September 1808 a junta was formed at Montevideo to promote the idea of independence. The example was followed by Quito and La Paz, and on 25 May 1810 took place the popular rising at Buenos Aires, which caused the flight of the Viceroy Cisneros and placed the power of government in the hands of a junta of nine. This is not the place in which to follow the vicissitudes of the movement. Montevideo, which had taken the first step, relapsed into Royalist hands, the Spanish forces not being finally expelled till June 1814.

About this time fierce antagonism developed between Buenos Aires and Montevideo. Since 1810 the former had sought more and more to found a state which should concentrate in its hands the power and centralized authority formerly wielded by the King of Spain. In the Oriental Province, on the other hand, that is the country now known as Uruguay, extending eastwards from the river of that name, though there was as yet no desire to sever the connection with Buenos Aires, the aim obstinately and consistently pursued by Artigas, the national hero of Uruguay, was to form a great confederation of Spanish-speaking states, each one possessed of entire autonomy and linked up with Buenos Aires by the loosest kind of federal tie. The two competing conceptions of the forms in which the emancipated states should clothe their newly gained independence were soon found to be irreconcilable. The centralizing patriots of Buenos Aires exchanged their junta of nine for a triumvirate which, in its turn, made way for a veiled dictatorship in the hands of Pueyrredon, styled, by the Congress of Tucuman in July 1816, Director of the United Provinces. Senhor Nobre considers there was little to distinguish the administration of this leader from that which had previously been directed from Spain. Pueyrredon had no belief in constitutional assemblies and regional autonomy. Artigas held very different views. He would have no truck with the scarcely disguised autocracy which was again coming into fashion at Buenos Aires, and which in later days took the form of the tyrannical military dictatorship of Rosas. During the brief time he was able to hold the reins of government in Montevideo, the popular support of his admiring countrymen enabled him to lay the foundations out of which the liberal institutions of the modern State of Uruguay have grown and developed. Both at Buenos Aires and Montevideo

danger had ceased to threaten from the old world, but the conflicting ideals of the two cities led to civil war between them.

In 1815 Artigas, by his personal ascendancy, succeeded in concentrating round his person the representatives of a Federal League including, besides his own Oriental Province, the whole of the territories now constituting the northern part of Argentina. The River Plate leaders, in desperate reaction against the prospect of absorption in an all-embracing Spanish-speaking federation, as conceived by Artigas, summoned in 1816 a congress at Tucuman, which declared the Independence of the United Provinces, and appealed to Brazil to join in putting down Artigas, the common enemy. So great did the danger appear to be that Pueyrredon went so far as to invite King John VI. to place his queen, the ambitious Doña Carlota Joaquina (Spanish Infanta, sister to Ferdinand VII.) on the throne of Buenos Aires. Thus would be formed, it was hoped, an Empire of the River Plate, conterminous with the Empire of Rio de Janeiro.

The various monarchical schemes devised about this time by the River Plate chieftains are related in interesting detail in the volume under review. Senhor Belgrano was first deputed to London to beg for a British protectorate. Passing through Rio on his way he was snubbed by Lord Strangford, the British Minister, and the idea was finally rejected by the British Government, who were unwilling to offend Spain, their recent ally in the Peninsular War. Belgrano next proceeded to Rome with the formal request that the ex-King Charles IV., father of the reigning King of Spain and now residing in the Papal capital, should allow one of his sons, the Infante Don Francisco de Paula, to accept the throne which was going begging. The old king would accept no such favour from a republican and rebel Government. Still bent on securing an emperor for his country, Belgrano, on his return to the Plate, searched for a time for some descendant of the old Inca rulers of Peru, who might be willing to marry a Portuguese princess and thus to resume the crown of empire. Anything, in short, would be better than to suffer the upstart Artigas to dominate South America. These reactionary plans were regarded with favour by King John VI., now shortly to become the Emperor Pedro I. of Brazil. He sent an army in 1817 to occupy the Cisplatine Province, as the Oriental Province now came to be called, and, though Buenos Aires was shortly compelled by the popular sympathies of the bulk of the inhabitants with the patriots of Montevideo to take up arms against the Brazilian invaders, he retained possession of the country for many years. Even before, in 1822, he had proclaimed from San Paulo the independence of Brazil and secured for himself the Imperial dignity, he had been able to induce the Cisplatine Province to vote its annexation to Brazil. On 9 May 1824 the new constitution was formally recognized and accepted at Montevideo.

But the hour of liberation was approaching. A raid from Buenos Aires, known as the crusade of the 33, that being the number of the devoted band, speedily developed into an army capable of standing up to the Imperial forces. Artigas had now disappeared from the scene, but his mantle had fallen on Lavalleja, who was acclaimed Captain-General of the Province and summoned a congress at Florida to declare its independence. Rivadavia, the new Director at Buenos Aires, sent his best general, Alvear, to command what now came to be termed the United Republican Army. On 20 February 1827 was fought the hotly contested but indecisive battle of Ituzaingo in Rio Grande do Sul. Both sides were now getting tired of a conflict which had lasted over seven years. Rivera, the associate of Lavalleja, brought matters to a head by

conducting an independent invasion of the territory of the former Jesuit missions, an important tract of country lying well within the limits of Brazil. Rio was exhausted, and so was Buenos Aires. Lord Strangford and Lord Ponsonby, the respective British Ministers, used all their influence to bring about a peace. A preliminary convention signed at Rio on 24 May 1827 constituted the final and vain effort of Pedro to retain a hold over his Cisplatine Province. It was indignantly rejected at Buenos Aires and Montevideo. In the end, under strong British pressure, the Treaty of 28 August 1821 was signed at Rio, both parties recognizing the complete independence of the province so long in dispute and now soon to become known as the sovereign state of Uruguay.

So were finally fixed the Southern frontiers of Brazil, running, as they now do, in a fairly straight line from a point on the Atlantic near the southern end of Lake Mirim in a north-westerly direction to the confluence of the Quarain with the Uruguay.

Considerations of space forbid more than the briefest reference to the second part of Senhor Nobre's work, which treats of the River Plate itself, its navigable channels, the islands within its waters, and the questions of jurisdiction which arise. The author is chiefly concerned to defend the claim of Uruguay to have restored to it the Island of Martin Garcia, already mentioned above as having been occupied by the Portuguese as their southern outpost simultaneously with Colonia in 1680. He contends that this island has never ceased to belong *de jure* to the Oriental Province (Uruguay). In point of fact it is still claimed by Argentina. The island was indeed at one time a place of considerable strategic importance, as commanding the channels by which alone the great waterways of the Paraná and Uruguay rivers can be reached. This advantage it has long since lost under modern conditions, and its possession by Uruguay is now demanded on sentimental grounds only. There are maps showing the channels at present available and the long roundabout course which has to be followed by vessels bound from Buenos Aires to the ports of the great rivers. One of the channels most in use passes between the Island of Martin Garcia and the Uruguayan mainland. It was discovered in 1855 by an officer of the United States steamer *Water Witch*, as recorded in the *Proceedings of the Royal Geographical Society*, vol. 1, p. 170. Rather complicated questions arise as to jurisdiction over the waters of the River Plate. They are dealt with in detail by Senhor Nobre.

The issue of the struggle for independence in South America was largely determined by the careers and final triumphs of Bolivar, Sucre, and San Martin. These great names are hardly mentioned by Senhor Nobre, who confines his interesting and instructive narrative to the development of the movement on the Atlantic side of the continent. He will render much easier to English readers the full understanding of portions of his work if, in future editions, he finds it possible to insert a few coloured maps showing clearly the successive frontier lines which he describes, and many of the localities mentioned which are not easily identified even in the best maps, however familiar they may be to the South American reader.

MAURICE DE BUNSEN.

THE SECOND MOUNT EVEREST BOOK

The Assault on Mount Everest, 1922.— Brigadier-General the Hon. C. G. Bruce, C.B., M.V.O., and other Members of the Expedition. London: Edward Arnold & Co. 1923. Pp. xii. and 340. *Maps and Illustrations.* 25*s. net.*

THE Mount Everest book of 1921 'Mount Everest: the Reconnaissance,' has now its sequel in a second volume, 'The Assault on Mount Everest.' The object of the first Expedition was purely one of reconnaissance; the object of the second Expedition was to climb the mountain, and this book is the story of the gallant attempts made to reach the summit. Both authors and publishers are to be congratulated on having been able to put into the hands of the public a second volume of such entrancing interest, and at such a moderate price. The sequence of the story is well arranged, especially its division into the general narrative of the Expedition, followed by the successive attempts to climb the mountain, with chapters on acclimatization at high altitudes, and on Natural History.

In General Bruce, the leader of the second expedition, the Royal Geographical Society and the Alpine Club were fortunate in having a man who had spent nearly thirty years of his life in the Himalaya, and who knows the conditions of climbing there probably better than any other living man to-day; who understands the Himalayan peoples and how to handle them. As any climbing party is dependent upon native porters, it was essential that there should be with the Expedition some one who could humour and get the best out of them. He could not be expected at his age to take part in the climbing, but for the command of the Expedition no better Leader could be found.

The volume starts with an introduction by Sir Francis Younghusband, who deals with the necessity of enlisting a corps of porters, the selection of the climbing party and the personnel of the Expedition, and the necessary equipment. The great question was whether the Expedition were to take oxygen with them or not, and this was finally decided in the affirmative. He then goes on to discuss the question which had been repeatedly asked him, "What is the good of it all, and who will benefit if the climbers eventually get to the top?" His conclusion is that human beings by it will gain an increased knowledge of their own capacities that they cannot know until they try; and that the standard of human achievement is being raised every day. His philosophy implies that a new enjoyment of life will be opened up, that for one precious moment the climbers are lifted above their ordinary life, and that after all the enjoyment of life is the end of life.

The story of the Expedition is admirably told by its leader, who takes us from the start at Darjeeling. The chief problem was to advance into Tibet at the last possible moment, in order to avoid the very worst of the winter's cold, and yet at the earliest possible moment, so that the Expedition could arrive at the foot of Mount Everest with sufficient time to attack it before the weather broke and the monsoon started. The Expedition left Darjeeling on March 26, the journey across Sikkim being uneventful, and it was too early to enjoy the beauties of the hillsides covered with rhododendrons. The principal difficulties of the former Expedition were avoided by employing the local Tibetan mules, which regularly cross the Jelap La, and which are the hardiest and best form of transport available. From Phari onwards the Expedition struck the true Tibetan spring weather: blizzards and icy winds with the ground

still frozen hard. The route followed was that of the Expedition of 1921, past Kampa Dzong to Tinki, and on to Shekar, but from Shekar, instead of going on to Tingri Dzong, a new route over the Pang La brought them to the Rongbuk valley, and to the interesting Rongbuk Monastery, where General Bruce made great friends with the sympathetic and saintly Rongbuk Lama, who could understand the object of climbing Mount Everest when it was explained to him that it was a sacred pilgrimage.

By May 1 all the outfit of the Expedition had been collected at the Base Camp. It needed good staff work to keep the high camps supplied with fresh meat, flour, and fuel, as the supply of coolies was difficult to assure.

Captain Noel was the official photographer of the Expedition, and as the exceptionally beautiful illustrations in this volume testify, he had his time from now on fully occupied. He was quite indefatigable, taking a kinematograph camera with him to the North Col, where he remained for four nights at 23,000 feet—a remarkable *tour de force*. His kinematograph film of the journey, the climbing, the Tibetan dances and festivals, and strange monastic life is deservedly well known. Other members of the party, also, have contributed excellent pictures to the book: notably the photographs by Captain Finch from about 24,000 feet, and those by Mr. Somervell at 27,000 feet.

General Bruce also gives an account of a trip that he made to the beautiful Kharta valley after the climbing season was over. This valley with its lower elevation was looked upon as a sanatorium for the Expedition, where the climbers could recover from the effects of the high altitudes and the excessive dryness of the Tibetan atmosphere. After the barren solitudes the sight of the beautiful green grass, the Alpine flowers, and the bushes and shrubs helped the recovery of the health of the party. The Dzongpen of Kharta proved as friendly to the new Expedition as he had been to the former. Some of the party made a trip to the Kama valley, but the weather by now had badly broken, raining steadily every day and with the mists low down in the valleys and hiding every view. The most interesting of the smaller journeys was that of Captain Noel and Captain Morris up the gorges of the Arun into Kharta. This path had never been traversed by Europeans before. No great waterfalls were found, but a wonderful gorge covered in the richest vegetation, with the mighty rushing stream, above which towered great cliffs disappearing into the mists above, and a path that climbed thousands of feet to avoid a cliff only to descend the next moment to the level of the river.

The chapters written by Mr. Mallory form a delightful and thrilling narrative of high literary quality. His vivid description of the beauties of the scenery of the new wonderful world that opened before their eyes will make every mountaineer envious. He describes the delights and discomforts of camp life on the glaciers in a very human way: the begoggled crowd that moves with slow determination up the mountain slopes, the little army of cylinders containing oxygen, or the pleasures of the table at high altitudes with quails and truffles and other delicacies.

The way to the North Col, the only possible approach that led to the summit, was not without difficulty and danger. By May 19 a camp was established and fully provisioned there, and the first attempt was made on May 20. The first climbing party was Mallory, Somervell, Norton, and Morshead. The slopes up which they started were not difficult, but the unfavourable wind of Tibet soon sprang up, and after reaching a height of 25,000 feet a camp had to be made. High bivouacs are seldom comfortable, and this was no exception. By night several of the party had already suffered from frostbite, but in spite

of the discomfort they were able to console themselves with the fact that they had pitched a camp at 25,000 feet, an altitude that no climbing party had ever reached before. The following morning broke fine, but Morshead was unable to proceed, and the other three started without him. It was luckily possible to climb almost anywhere on these broken slopes. Had it been otherwise they would have been unable to proceed, and Mount Everest would remain for ever a virgin peak. But even without any difficulties the rate of progress was slow, too slow to reach the summit in one day, and after reaching a height of 26,985 feet it was decided to turn back, and by 4 p.m. the high camp, where Morshead had been left, was reached. The descent to the North Col was painful, and almost ended in a catastrophe. Camp was not reached until 11.30 p.m. by an utterly exhausted party, only to find that there were no cooking-pots in which to warm up any food. The following morning they were just able to crawl down to Camp 3, and thus ended the first real attempt on the mountain.

The story of the second attempt is told by Captain Finch, who was in charge of the oxygen apparatus, which needed constant and expert attention. Various little improvements were made in the mouthpieces, as the original masks proved impossible to use. On May 24 Captain Finch and Captain Geoffrey Bruce, with Corporal Tejbir, started on the second attempt, camping first at the North Col. Throughout this climb oxygen was used. Early the following morning porters were sent on to establish a high camp if possible at 26,000 feet, but by 1 p.m. the inevitable wind had so freshened and snow had begun to fall that camp had to be pitched at 25,500 feet. During the night the wind increased to a gale, and it seems to have been only a miracle that the tent was not blown over the precipice which descended sheer to the Rongbuk Glacier 4000 feet below. Climbing was again impossible the following day, as the wind did not drop till late in the afternoon. About 6 p.m., however, some porters, anxious as to the fate of the party, had climbed up from the North Col with Thermos flasks filled with hot drinks. Wonderful people they were, these Sherpa Bhotia, that could cheerfully face this long climb all by themselves with no Europeans to lead them and at heights never before attained by man. Without these cheerful and sturdy mountaineers the conquest of Mount Everest would be an impossible task, and all praise is due to them for their wonderful work. The second night was passed more comfortably than the first by sucking oxygen slowly, with the marvellous result that the party were actually able to sleep quite naturally. The following morning was clear, but soon after the start Corporal Tejbir collapsed, and could go on no further. The old enemy the wind began to freshen, so that it was necessary to leave the exposed ridge and traverse across the great northern face of the mountain. By midday they had reached a height of 27,300 feet, when an accident to Captain Bruce's oxygen apparatus necessitated a halt. To reach the summit now seemed impossible, and they realized that it was necessary to turn back. On their descent they passed their porters, who were cheerfully ascending again to the 25,500-feet camp to bring their kit down—the third time in three days that these porters had climbed up to over 25,000 feet.

Captain Finch's conclusions are that to reach the summit oxygen is absolutely necessary. He compares the rate of progress of the first party, who after leaving their high camp at 25,000 feet ascended only 330 feet per hour, with that of his party on the second attempt, who with oxygen made 900 feet per hour. He also advocates the use of oxygen between 21,000 feet and 23,000 feet, with increased quantities after 23,000 feet. He considers that only one camp above the North Col at a height of 26,500 feet would be necessary, and

that from that camp with a full supply of oxygen the summit could be reached in four hours, but that it would be necessary to make a dump of oxygen at 27,500 feet. He finishes his account with a chapter on equipment, which is extremely important if frostbite and sickness are to be avoided.

After the failure of the first and second attempts to reach the summit, it was determined to make a third attempt. Mallory and Somervell were the two fittest of the party, and were ready to undertake this task. On June 4 there was a heavy snowfall, and on arrival at Camp 3 they found the snow was from 15 to 18 inches deep. On June 7 they thought it would be possible to make a start for the North Col. Their intention was to use a modified amount of oxygen. After the start the snow was found to be deep and soft on the way to the North Col, and it was slow work, when suddenly the surface cracked and started to move slowly downwards carrying all the party with it. It would seem a miracle that the whole party were not buried, but as it was seven of the coolies were swept over an ice cliff into a crevasse and killed. This tragic calamity naturally brought to an end the third attempt to climb Mount Everest.

Mr. Mallory's conclusions differ from those of Captain Finch. He considers that two camps must be established above the North Col, one at 25,000 feet and one at 27,000 feet, and that porters could supply these camps without the use of oxygen, instancing the feat of some who climbed to the 25,500-feet camp three times, and accomplishing their tasks of carrying heavy loads quite easily. He considers also that if the high camp on the North Col could be made sufficiently attractive, it would be advisable to spend several days there in acclimatizing oneself before starting on the final climb. And he considers that it would not be impossible to reach the summit without oxygen.

Mr. Somervell adds a few notes on acclimatization, showing that it is not only possible, but is also quite rapid at these high altitudes, and that acclimatization at 23,000 feet should be sufficient for the attainment of the summit of Mount Everest. He also noted that each man had a different rate of acclimatization, and that some, especially the older ones, seemed to deteriorate in condition while staying at a great height. His conclusions are that it would be possible to get to the top of Mount Everest unaided and without oxygen, and he considers that the chances of climbing the mountain are probably greater if oxygen be not used, as the apparatus requires the use of a very large number of coolies.

A short chapter on natural history by Dr. Longstaff agreeably supplements the accounts of the climbing, but the acquisition of specimens was much restricted owing to the prohibition of the use of firearms in Tibet.

Altogether this second volume of the Mount Everest Expedition forms a fascinating story of adventure well told and full of interest from start to finish. If there is any criticism to make it is that more is not told of the expedition through the Arun gorges, and that there are no illustrations of that part of the country. There is also the same difficulty that the former Expedition experienced in the spelling of Tibetan names, the Tibetan pronunciation being totally different from the written characters, and in this volume the spelling of the names of places is at times not only different from that of last year, but also it does not agree with the spelling in the maps at the end of the volume.

C. K. HOWARD-BURY.

REVIEWS

EUROPE

Roman Britain.— R. G. Collingwood. Oxford Univ. Press. 1923. *Illustrations.* Pp. 104. *2s. 6d. net.*

THIS is a clearly written and persuasive attempt to correct the generally accepted version of the relations between Romans and Celts in these islands. Mr. Collingwood rightly insists that Roman institutions and civilization were not entirely alien elements forcibly imposed upon conquered peoples, and that there was no racial cleavage between Romans and subject races. This applies as much to Rome's occupation of Celtic Britain as to her relations with other races of the Empire. The Celts became " Romans " by travel, residence, and intermarriage, as well as by conquest. On this basis, after an outline of the history of the conquest and occupation, Mr. Collingwood proceeds to demonstrate the existence of a Romano-British civilization, distinct from Roman and Celtic, yet deriving its best elements from both. He illustrates the existence of a native style of sculpture, of house-building, of jewelry and of pottery. In the last case, the combination of Samian decorative patterns with " late Celtic " shapes to produce the distinctive Castor ware is strikingly shown. This tendency is also to be traced through other aspects of social life in Roman Britain. The writer does not press his case for the evolution of this distinct culture too far; the completeness with which it was swept away by the Saxon invasions would seem to show that it was not rooted firmly, though the absence of conspicuous fruits may have only been a question of time.

Story of the English Towns: Canterbury.— D. Gardiner. London: S.P.C.K. 1923. Pp. viii. and 128. *Illustrations.* *4s.*

For most people, Canterbury is the Cathedral, and the Cathedral alone. Its name calls up vague impressions associated with Augustine, Becket, and Chaucer's pilgrims. Yet Canterbury was a Roman town before the coming of Christianity, and still flourishes when the great days of the Cathedral have passed: consequently, in her history of the city, Miss Gardiner has endeavoured to keep church history in the background—to banish it altogether would be impossible. But for the accident that it was a royal borough, with a distinct corporate life of its own, the city's identification with the church would have been even more complete. As it was, the religious upheaval of the sixteenth century reduced it to " extreme poverty, nakedness and decay," a state of affairs only remedied by the influx of Flemish and Huguenot weavers and spinners, themselves the victims of religious troubles. From the seventeenth to the nineteenth centuries, the city's history is one common to English privileged boroughs. Miss Gardiner has throughout emphasized the social life of the citizens, thus producing an attractive and balanced account. Once again in dealing with this series, the absence of map or plan must be recorded.

The Highlands with Rope and Rucksack.— E. A. Baker. London: H. F. & G. Witherby. 1923. Pp. 254. *Illustrations.* *12s. 6d. net.*

In these sketches of his walks and scrambles, mainly in the less familiar Highland districts dear to members of the Scottish Mountaineering Club and other kindred fraternities, Dr. Baker deals with a fascinating and interesting subject in a vigorous and graphic style. He has a wide command of expression and descriptive power, such as might be expected from his experience of books and hills, together with a vivid sense of form, colour, and landscape. Perhaps

at times he is tempted to lay on the colours with a somewhat lavish hand, as in the references (p. 85) to the "yawning abyss," the "tumultuous throng," or the "huge vacuity" of some favourite prospect. The stories of some of the rock-climbs are thrillingly told and offer a signal refutation of the author's modest assurance that his book "chronicles . . . no feats of endurance"; the "direct ascent of the Crowberry Ridge" (of Stob Dearg) involved a siege which "lasted nearly a week," and was the only climb that could stand comparison "in difficulty and hazard" with Ben Nevis Chimney in Arran, and which, we are told, "might be said to equal . . . the three arêtes on Great Gable placed end on end." The reproduction of the photographs is hardly worthy of the spirited letterpress, and it is a pity that no map is included to enable the reader to locate the many names which are confusing by their very number, and which are repeated in the full and excellent index.

It seems a pity that the talented writer should allow himself to indulge in a sustained attack, both throughout the forty pages of introduction and frequently in the book itself, on the owners or tenants of deer-forests, etc., for the alleged injustices and restrictions inflicted on tourists in their neighbourhood. It is surely too much to say (p. 20) that "the deprivation which the British people sustain by the closing of the greater part of the Highlands is a social evil of the same kind and dimensions as would be the closing of the Alps to the people of Europe." Were that the case we should surely have heard a louder and more general outcry from aggrieved tourists than we have. We would rather believe that Dr. Baker's experiences have been somewhat exceptional, a view which finds support in the following authoritative pronouncements:

(1) "The members of the Scottish Mountaineering Club in the course of their pursuits fortunately do not often come into contact with the law. Still more seldom do they come into conflict with it. They have chosen a more excellent way. Their policy always has been to respect the rights of landowners, and they have had their reward in the generous treatment which they have almost always received from the proprietors of the Scottish mountains." ("Rights of Way," by H. P. Macmillan, K.C., in the *Scottish Mountaineering Club Journal*, vol. 14, p. 288.)

(2) Rule III. of the Scottish Mountaineering Club: "The members of the Club shall respect proprietary and sporting rights, and endeavour to obtain the co-operation of proprietors." W. W.

Lithuania: Past and Present.— **E. J. Harrison.** London: T. Fisher Unwin. 1922. Pp. 224. *Sketch-map and Illustrations.* 16*s. net.*

The history of Lithuania has been indissolubly bound up with that of her neighbours. As an independent state, she attained to her greatest prosperity during the fourteenth century, when her territory extended from the Baltic to the Black Sea. The proximity of two such aggressive rivals as the Teutonic Order of Prussia and Poland proved, however, her undoing. It was to meet the commercial competition of the former that she sought to establish relations with England, a policy which has been more successful to-day than it was then. The Union of Lublin marks the end of her mediæval greatness. Bound to her neighbour at first by consent, then virtually subjected to Poland, Lithuania shared her fate: yet despite this comradeship in misfortune, it is with Poland that, since her liberation, she has come into conflict. In this dispute, which centres mainly round the future of Memel and of Vilna, Mr. Harrison is a firm supporter of the Lithuanians, and states their case strongly. Until a real settlement is achieved, it is difficult to predict the future of this state. In foreign relationships, the present tendency is said to be towards a strengthening of the

bonds between Lithuania, Estonia, and Latvia. Internally, since Lithuania is essentially an agricultural community, the outstanding feature of the new *régime* has been agrarian reform, aimed at establishing an independent peasantry. It was estimated that during 1922, 525,000 acres, acquired by purchase and by confiscation, had been re-distributed by the government. At present Germany is Lithuania's best customer for her exports.

Over the Hills of Ruthenia.— **H. Baerlein.** London: Leonard Parsons. 1923. Pp. 246. *7s. 6d. net.*

Despite the efforts of the Peace Conference there still exist in Eastern Europe considerable minorities under external rule. Among these are the inhabitants of Ruthenia. Formerly under Magyar rule, they have been entrusted, during the period of their political adolescence, to Czecho-Slovakia. To the Czechs, the administration of Ruthenia presents considerable difficulty. The resources of the country are still undeveloped, and much of the improvement already carried out has been at Czecho-Slovakia's expense. Most of the population is illiterate, the peasants having, in the past, preferred to pay the annual fine and keep their children at home, rather than send them to school to become, in most cases, Hungarian in sympathy and outlook. As a result, the greater part of the administrative posts are filled by Czechs. In these circumstances, it is fortunate for Ruthenia that the Czechs under whose guidance she has been placed have a clean record in the treatment of minorities.

This is the general background of Mr. Baerlein's book. It is more difficult to do justice to his delineation of the attractive characters he met on his journeyings. He may have been exceptionally fortunate in this respect, but probably this impression is due to his depth of sympathy and insight, and the vigour and dry humour of his style, which make out of every chance passer-by an arresting and delightful personality. One can hardly doubt, after reading his book, that the Ruthenes, when they become fitted to claim that autonomy which is their acknowledged right, will not be unmindful of their indebtedness to their Czech friends and teachers.

ASIA

My Nestorian Adventure in China.— **F. Holm.** New York: F. H. Revell Co. 1923. *Sketch-map and Illustrations.* $3.50.

The monument near Si-an Fu in the Shensi Province of China, with its extremely interesting inscription, dated 781 A.D., recording the arrival of Nestorians in China in 685 A.D. and summarizing the tenets of their religion, was first brought to the notice of the foreign world by the late distinguished sinologue Mr. Alex. Wylie. His translation of the inscription has been followed by many others. Mr. Holm's study of it at the British Museum led to a daring plan to carry off the monument, and present it to the British Museum, or some other sanctuary of the same kind, where it would be safe from injury.

The present volume tells the story of his journeys in the prosecution of this idea, which was modified by circumstances to that of obtaining a perfect replica of the monument. This was no easy task, for a general suspicion was aroused that he had designs upon the monument itself, and the transportation of the stone replica, weighing 2 tons, was in itself an extremely difficult undertaking. The stone has now been placed in the Vatican, after having been exhibited for eight years in the Metropolitan Museum at New York.

One surprising result of Mr. Holm's quest has been that the Chinese authorities, who never previously evinced any interest in the monument, have

now removed it to Si-an Fu, where it stands alongside of the stelæ containing the Confucian classics. It remains to be seen whether this will prove a safer home than it enjoyed in the obscurity which saved it from injury during the Boxer rising.

Among other illustrations in the volume is an excellent photograph of a colossal Buddha hewn in rock in the Sung Mountains of Honan. Mr. Holm records with sorrow that since his visit many statues in that neighbourhood have been decapitated by or for foreign vandals in search of Chinese antiquities.

W. R. C.

The Sulu Archipelago and its People.— Sixto Y. Orosa. London: Harrap. 1923. Pp. ix. + 134. *Illustrations and Map.* 2s. 6*d. net.*

The Sulu Archipelago, a chain of some three hundred islands and islets of volcanic and coral origin, strung out between Borneo and the Philippines proper, was a source of unending trouble to the Spanish authorities and, later, to those of the United States. Supervision was difficult, and consequently the islands afforded ideal shelter for the pirates who ranged the Malayan seas and to smugglers of guns and opium. In 1899 the Sultan formally recognized American sovereignty over his dominions, but the islands continued in an unsettled condition, with many native risings, until 1915, when a "policy of attraction" was inaugurated. Civil Government then replaced military law, and the prevailing religion, customs, and practices of the natives were respected, so that, according to the author, "what had not been attained by hundreds of years of warfare was attained in a few years by wise administration."

Dr. Orosa's general account of the islands and their inhabitants does not err on the side of impartiality, but is written with sympathy and insight. The book is well produced, but would have been improved by an index and a better map.

O. R.

Szechwan: its Products, Industries, and Resources.— Sir Alexander Hosie. Shanghai: Kelly & Walsh. 1922. Pp. 186. *Two Maps.* $5 (Mex.).

In 1881, within five years of the opening-up of Szechwan to British traders, Sir Alexander Hosie was sent to Chungking to watch over their interests. This was the beginning of that close connection with the province, so long maintained by him, which has resulted in a most intimate knowledge of its social and economic structure. This book is based, with necessary additions, upon an exhaustive study of the products and manufactures of the province made in 1903, the results of which appeared later as a Parliamentary paper.

Though one of the largest and richest provinces of China, Szechwan has not yet become a great market for European trade. Apart from the present political distractions, this is due in the main to the difficulties of communication. The three months' journey by junk from Ichang to Ch'engtu increases enormously the price of imports, and until recently the rapids of the Yangtse above Ichang have proved an obstacle to steam navigation. This difficulty has been overcome, and steamers are now run profitably between Ichang and Chungking, the winter months excepted. The further solution, the building of railways, has been deferred by political reasons. The potentialities of the great province, with its population of forty-five millions, thus being developed are described in great detail by Sir Alexander Hosie. Self-supporting in the main, its products are chiefly agricultural. A considerable export trade in brick tea is carried on with Tibet, and of the other industries tobacco, silk, salt, and opium are among the most important. Cotton growing has declined through the com-

petition of cheap manufactured yarns imported from India and elsewhere. Mineral resources include gold, copper, and iron. For every industry the details of the process are given in full, with criticisms and suggestions for improvement. These have in several cases already borne fruit, as in the silk industry, testifying to the value of this thorough piece of work.

Angkor: Ruins in Cambodia.— F. Jeannerat de Beerski. *With 65 Illustrations reproduced from drawings by the author and from photographs.* $8\frac{3}{4} \times 5\frac{1}{2}$, pp. 304. London: Grant Richards, Ltd. 1923. 18*s. net.*

The literature relating to Angkor is fairly voluminous, but most of it is in French, and the present work will therefore be welcomed by many English readers. It is an appreciative description of those remarkable ruins, which for their great scale and their artistic value rank high among the wonders of the East. As a modern poet has said :

> "The lotus-towers of Angkor rise
> In swamp and forest,"

and for some centuries they were lost, at any rate so far as European knowledge of them was concerned. And yet it might be truly said that not merely in the rest of Indo-China but in all Asia there is

> "No pomp of avenues or towers
> Like Yasovarman's moated seat
> In Angkor, where the jungle flowers
> Entangle Mahesvara's feet."

M. de Beerski's account of these great structures is not a mere technical enumeration of their proportions and beauties. He conveys by vivid touches the impressions which they made upon him. The local colouring is strongly rendered, and he also draws on history, myth, and religion to illustrate and explain the inner meaning of what he has seen. It is plain in all he writes that the great local efflorescence of Indian civilization embodied in these immense buildings and their decorative embellishments has touched him deeply; and his book is largely an essay in interpretation. Under his guidance we see the old Khmer monuments again endowed with life and purpose.

Regarded from that point of view, the work must be pronounced a very successful achievement. No one can read it without entering in some degree into the mental attitude of the author and being led to a sympathetic understanding of his subject, unless indeed it happen to be some very matter-of-fact reader, who might consider it all somewhat overstrained. The author's language is, it must be admitted, florid, exotic, and occasionally studded with un-English words and idioms that may jar upon the average English reader. But it rings true nevertheless, and it would be out of place here to cavil at some remarks which are open to criticism on the score of strict scientific accuracy, such as, for example, the statement that the Khmers are "decidedly Aryan in every characteristic."

As regards the illustrations, it is to be regretted that the drawings are in many cases so sketchy. They compare very unfavourably with the photographs. It would have been better to render all the sculptures and decorative details by photographic process; and for the architecture also photography, or failing that, a more architectural style of drawing, would have been more suitable. The essence of these things is largely inherent in their details, which are apt to evaporate in rough impressionist sketches.

An index would have been a useful addition; but there is a fairly full Table of Contents.

C. O. BLAGDEN.

AFRICA

The Royal Chronicle of Abyssinia, 1769–1840.— With Translation and Notes by **H. Weld Blundell, B.Litt.** Cambridge: University Press. 1922. 11 × 7½, pp. xv.+543. £2 10s. *net.*

This is a notable contribution to Ethiopic philology and history. Mr. Weld Blundell gives from a manuscript in the British Museum the Ge'ez or Ethiopic text of a portion of the Royal Chronicle of Etyopiya, as the inhabitants denominate the country which English writers call Abyssinia. He says (p. xi.) "it is dated 7344 = A.D. 1851" (but Genbot 7344 = May 1852); it is really the work of different court officials or royal historians who themselves took part in some of the events narrated. The earlier portion is written very fully in strict chronological sequence, and dates are given with evident care, with the year from the creation of the world, Evangelist year, epact of the moon, day of month and week, and so on. Yet this does not prevent some errors (and omissions), which should have been detected and corrected, as when the events of 7282 are dated under "7283" (p. 416), or King Takla Giyorgis (p. 470) is called "Takla Haymanot." The translator shows inexactitude in the conversion of Ethiopic dates into Gregorian; his list of kings on p. 510 contains several wrong dates; and failure to grasp the scribe's mode of reckoning has led to a series of mistakes on p. 484.

The period covered by the narrative is from the reign of Takla Haymanot, 1769 to 1832, wrongly dated "7322" (A.D. 1829–30), the last thirty years being in very brief summary, as the writer was then in captivity (p. 470). Subsequent events to 1840 are printed from a MS. in the Bibliothèque Nationale, Paris. It is interesting to compare the story of the earliest events with the account of Bruce, who was in the country in 1769–70. From that time, with the exception of Henry Salt's two visits (1805 and 1810) and the subsequent residence of Nathaniel Pearce and W. H. Coffin, we know little of the country till the journeys of Ehrenberg and Hemprich (1825), Gobat (1830–2) and Rüppell (1831–4). The land was distracted throughout by civil war between rival provincial governors and in the throes of a racial struggle with the Gallas, who from the time of Muhammad Grañ in the sixteenth century were steadily permeating the country. The kings were reduced to puppets by the intriguing Rases. The country was much restricted in area, being practically confined to the provinces of Tigre, Amhara, Begameder, Dambaya, Gojam, and Damot. Shawa (Shoa) was independent; and, as the struggles went on, during the reign of Takla Giyorgis, Tigre, which alone seemed able to stem the Galla tide, became separated from the southern provinces, which were overrun by the invaders. The Gallas owed their power to their being more prolific than the Abyssinians; but gradually the balance was turned by the importation of guns and cannon through Massowah, and Tigre got the upper hand. The struggles were so engrossing that we are told nothing of outside countries, beyond embassies from Sennar and a mission to Egypt to obtain a new Abuna, nor is there any mention of European travellers. Mr. Blundell gives in appendices some details of the Galla, Falasha, Agow, and other tribes, and brief notes on places mentioned. There is no index. F. A. E.

Across the Great Craterland to the Congo.— **T. Alexander Barns, F.R.G.S., F.E.S.** With an Introduction by **J. W. Gregory, D.Sc., F.R.S.** London: Ernest Benn, Ltd. 1923. Pp. 276. *Sketch-maps and Illustrations.* 25*s.* net.

This is the second book on African travel from Mr. Barns within the last two years. His last was 'The Wonderland of the Eastern Congo,' to which

the present book is in some respects a sequel, and it makes a forcible appeal to any one interested in Central African travel, natural history, and big-game shooting. Mr. Barns was accompanied by his wife, as on his previous journey. The route taken was from Mombasa to the great crater country west of Kilimanjaro, in what was formerly German East Africa, and thence to lakes Tanganyika and Kivu, the Congo Forest, lake Mweru, and then on by well-known routes and rail to South Africa.

Dr. Gregory's introduction deals with the great craterland country (on which the first accurate information was obtained by Oscar Baumann in 1892), with its volcanic problems, and with questions concerning the great rifts of Central Africa; the rest of the book consisting of Mr. Barns' personal narrative of the journey.

Arusha, which is the stepping-off place for the crater country, is spoken of in enthusiastic terms as having a good climate, fertile soil, perennial streams, and a great wealth of tropical and sub-tropical trees and plants. The highlands of the great craters begin some 75 miles due west of Arusha. Mr. Barns gives a most fascinating account of the greatest of all craters, Ngorongoro, which has been inactive for many thousands of years and now consists of a more or less level basin—some 10 to 11 miles in diameter, covered with a luxuriant growth of clover—in which are collected enormous quantities of African game of all descriptions. On this portion of his journey Mr. Barns was accompanied also by Sir Charles Ross, who, it is understood, has recently become the owner of a considerable portion of the Ngorongoro crater.

The book is copiously illustrated with excellent photographs, many of which show herds of game of different descriptions. Lions, we are told, are unusually numerous in Ngorongoro; they are spoken of by the author as "daylight lions," and can be found at any time by beating up small patches of cover. The idea occurs to one that the Ngorongoro crater would have formed an ideal game reserve, being surrounded by a well-marked rim outside which the game never goes. Mr. Barns says, "Without the aid of our glasses we could see that such a concourse of wild animals were collected within this giant 'ring-fence' as Africa's best big-game days could scarcely equal. The enclosure of the crater must have reached a circumference of well over 35 miles, giving plenty of room, one would imagine, for all the animals it contained, and yet in many places their numbers were so great that there seemed to be a 'crush' of game. . . . By reason of its vastness, its novel surroundings and scenery, its brooding mystery and teeming life, Ngorongoro far surpasses in my opinion such sights as Kilimanjaro or the Mountains of the Moon, or even the great Kivu volcanoes. Of such a place one might well say, 'See it and die,' for surely no place was ever half so beautiful. . . . Our first march across the floor of this colossal amphitheatre was a wonderful experience, made more so, if that were possible, by the kind of triumphant procession to which we were treated by a never-ending mixed herd of wildebeeste, hartebeest, zebra, and gazelle." The elevation of the floor of Ngorongoro crater was found to be 5800 feet above sea-level, the surrounding highlands being about 2000 feet higher.

Ngorongoro is not the only great crater in this region, for several others, such as Ololmoti, Oldeani, Elanairobi, and Oldonyo-lengai, rise to heights of 10,000 feet and over, the last-named being an active volcano.

After some exciting times at the crater with rhinoceros and lions, and after exploring a great part of the volcanic region, the author finally made his way to the Ujiji railway and thence to the Upper Congo and through the forests to lake Kivu, on his way exploring the interesting region of the Mokoto lakes

which lie a short distance north-west of Kivu. On the journey from Walikale to Mokoto—on the very backbone of Africa—some difficult country was passed through, being entirely covered with dense forest, frequently bitterly cold and exposed to terrific storms which are of almost daily occurrence. As Mr. Barns points out, the region of the Mokoto lakes, which forms the western boundary of the great volcanic region immediately north of Lake Kivu, still presents most interesting problems, and invites scientific exploration. He is of opinion that the chain of Mokoto lakes consists of three only, named Ndalala, Lukulu, and Bita. He considers that they are of quite recent formation, geologically speaking, and that their formation is due to volcanic *débris* shot out by successive eruptions of the Namlagira volcano. He also considers that the lava from Namlagira has never flowed beyond the original wall of the rift valley. He found the level of Lake Ndalala, one of the chain, to be " 5480 feet above sea-level, or 600 feet above that of Lake Kivu," and holds that none of the ancient lava-fields in the Mokoto district could have been deposited there from Namlagira, as, although there appeared to be an ancient break in the western wall of the rift valley, this, at any rate in the present day, is filled up by volcanic *débris*.

When I visited the Mokoto district in 1912–13 with Mr. Elphinstone, we were informed by the natives that there were four lakes, but had no opportunity of verifying or disproving the statement. There can be little doubt, however, that the lakes do not drain to Lake Edward, as we thought possible, and that Mr. Barns is right in his opinion that they are discharged to the Congo. It is, as stated by Mr. Barns, a most interesting question to ascertain whence the Mokoto lava came from, a subject on which I have already made some remarks in this *Journal* (vol. **60**, p. 238).

Mr. Barns speaks enthusiastically about the beauties of Lake Kivu and the surrounding districts, and there is much more about this region which might be said in a review of his book, but space is too limited. After descending the Rusisi valley to lake Tanganyika the author voyaged down that lake to its southern extremity, then crossed over the interesting Marungu plateau to lake Mweru, on to Katanga, and thence by rail to Capetown. The book can be thoroughly recommended. A. S.

The Bakitara or Banyoro.— **John Roscoe.** Cambridge University Press. 1923. Pp. xvi. and 370. *Sketch-map and Illustrations.* 25*s. net.*

This important work is the first part of the report of the Mackie Ethnological Expedition to Central Africa, and deals with the people of the portion of the Uganda Protectorate known generally as Unyoro or Bunyoro.* It treats in a very complete manner with the life-history of these people in its various aspects from birth to death.

The writer's task has been complicated by the fact that the country he describes is occupied by two races, and, as is usual in such cases, a certain amount of contact metamorphism has taken place. A pastoral tribe of Hamitic descent, now known as the Huma or Hima people, entered the uplands of Unyoro from the N.N.E. at some remote period and established domination over a Negro race which they found settled there. It was to be hoped that Mr. Roscoe's careful investigations would have thrown some light on the history of this invasion, but these hopes have not been realized. The list of Huma rulers probably goes back some four hundred years, and it is curious that there is

* The second part of Mr. Roscoe's report, dealing with the Banyankole (price 15*s. net*), has appeared since the above review was written.—ED. *G.J.*

little legendary lore dealing with their migration from the north or their life in their original homeland. Another remarkable fact is that the invaders have lost practically all trace of their original language and now speak a Bantu tongue of a somewhat archaic type.

It is alleged that the Bantu invasion in the eastern half of the continent does not date back more than fifteen hundred to two thousand years, and if that is so then it is probable that the Huma migration did not occur till somewhat about mediæval times. The Bantu-speaking invaders were, however, by no means the earliest inhabitants of this region, for they were preceded by a race who made and used the stone implements which have recently been discovered in Uganda and Unyoro by Mr. Wayland, and this culture certainly goes back to early Neolithic times, possibly much earlier.

The disappearance of the Huma language is remarkable, for until very recent times the Ba-Huma kept themselves very much aloof from their Negro serfs and rarely intermarried with them. Long contact between the two races has, however, had the effect of causing each section to adopt many of the customs of the other, and it would appear that it is often difficult to assign the origin of particular beliefs and ceremonial rites. Generally speaking, most of the arts and crafts appear to be derived from either the Negro (Bantu) serfs, or some, possibly, from their Stone age predecessors: the working of iron, the art of pottery, canoe building, salt making, would all appear to owe their origin to the natural ingenuity of the Negroes which now form the serf class.

Like the Masai in the neighbouring colony, the Ba-Huma had few interests outside their cattle, and from early youth to death these animals formed the absorbing feature of their lives. In course of time a very elaborate ceremonial was evolved in connection with their chiefs, for their ruler, when he succeeded to this position, became, may we say, the victim of a very extraordinary ritual in regard to the drinking of milk which formed his principal diet. These potentates, or Mukama as they are styled, were great autocrats; they were further the high priests of their people, in whose eyes they narrowly escaped deification. It is probable that in some mystic fashion it was felt that all this curious ritual had some magical value in preserving the health of their precious herds of cattle. In one of the folk-tales collected by the author it is stated that Mpugu, the first of the line of rulers who came from the east of the Nile, knew nothing of the cow customs. This is very difficult to explain.

It would take too long to give even an outline of the intricacies of this ritual, but ethnologists will feel gratitude to Mr. Roscoe for the careful manner in which he has recorded it all. It is believed that when more complete studies of the tribes east of the Nile become available we shall probably be able to discover whence this remarkable cult was derived.

The work is written in simple language and is well produced by the Cambridge University Press. It will long remain the standard authority on these interesting people, and will further enhance Mr. Roscoe's reputation as a reliable field ethnologist. C. W. H.

AMERICA

A History of the Canadian Pacific Railway.— Harold A. Innis, Ph.D. London: P. S. King & Son, Ltd. 1923. Pp. 365. 12*s.* 6*d.*

The author is lecturer in the Department of Political Economy in the University of Toronto, and he has produced a volume of threefold value. In the first place it sketches the broad lines of Canadian history which culminated in both the need and the desire for a trans-continental railway: the conflicting

commercial and political interests of both the fur trade and settlement, the desire on the part of Upper and Lower Canada for a "road" to the west, and the demand of British Columbia, as a condition of federal union, for the construction of "a trans-continental waggon road connecting Lake Superior and the head of navigation on the lower Fraser." Secondly, the main portion of the book is devoted to what one may style the more immediate history of the Canadian Pacific Railway; the stages by which it was accomplished, the political difficulties attendant on its construction, and the financial and other obligations incurred both by the Government and the Company. Lastly, the voluminous footnotes and the bibliography make the book a useful work of reference.

Two major effects of the construction are touched upon by the author. The opening up of the wide expanse of undeveloped country which separated the west from the east brought in its train the construction of the lake ports with their enormous grain elevators, and the creation of a fleet of "whale backs" for the transport of grain. But if the linking of the east and west resulted in the development of the central regions, the construction of the line as a whole, with its extension in a fleet of Pacific and Atlantic steamers, makes a link between the Orient and the Occident with a consequent development of the Dominion as a whole.

Occasionally the author's style and phraseology make it difficult to follow both his meaning and conclusions. The conclusion of one long argument begins thus: "The spread of western civilization, especially in the region roughly included in the Hudson Bay drainage basin, long delayed by the inhospitable barrier north of Lake Superior, led to the construction of technological equipment represented by the physical property of the road, and with its construction was greatly hastened." Nevertheless, as a work of reference and for its suggestiveness, it is valuable to the historian and to the geographer who can supply the essential physical background. W. H. B.

Across America by Motor-Cycle.— C. K. Shepherd. London: E. Arnold & Co. 1922. Pp. xii. and 248. *Illustrations.* 12*s.* 6*d. net.*

To remove "that haunting feeling of unrest" consequent upon four years of active service, Mr. Shepherd started out from New York to cross America by motor-cycle on 13 June 1919, and arrived at San Francisco on August 7. A feature of his spirited account of the journey is the absence of out-of-the-way adventures—even the Santa Fé trail has been deserted by romance. As the writer puts it, he neither shot at, nor was shot at by, anybody. Nevertheless, he gives us his impressions of a side of American life which has received considerable attention from rising novelists, that of the dwellers in the Middle West. He has encounters to relate with fellow-travellers, "judges," storekeepers, the inevitable journalist out for copy, and of course garage proprietors. His tale has much to say of the shortcomings of his machine and the roads, which were not always so good as might be. Towns and rivers marked on the map often failed to materialize; while as for his machine, he was thrown off at least 124 times, and almost every part of his engine had been replaced before the finish. Doubtless the cure proved effective!

Gypsying through Central America.— E. Cunningham. London: T. Fisher Unwin. 1922. Pp. 259. *Sketch-map and Illustrations.* 21*s. net.*

Mr. Cunningham and a companion landed at Punta Arenas in Costa Rica, and made their way, on horseback, on foot, and by rail, northwards to Puerto Barrios on the Caribbean Coast of Guatemala. This account of their journey

gives an interesting survey of the daily life of the peoples of Central America, though the author's attempts at "fine writing" become rather wearisome at times. As might be expected, they came into frequent contact with local officialdom, which they found to be quite as haphazard, as inefficient, and as ludicrous as it is generally represented. A similar underlying attitude towards life was observable in the habits of the people. Everywhere, at least in the country districts, century-old methods ruled, any attempt at innovation and improvement meeting with a sullen resistance. The misery, poverty, and apathy of the people in general, but particularly in Nicaragua, are constantly dwelt on. In Guatemala city, for instance, little had yet been done to repair the ravages of the earthquake of 1917. Throughout the journey the villagers showed much hatred of strangers, but apart from a slight brush with bandits, the travellers met with no open hostility.

In politics the same characteristics were apparent. While in Guatemala city they witnessed a large anti-government demonstration in favour of the federation of the five Republics, but elsewhere this policy does not appear to arouse much enthusiasm. The writer does not express a definite opinion as to the future of these states under their own initiative, but he is clearly not very hopeful. As he urges a more scientific study of Central American methods on the part of American merchants, and speaks well of American intervention in Nicaragua, his general standpoint is evident.

The New Argentine.— **W. H. Koebel.** London: T. Fisher Unwin. 1923. Pp. 30 and 276. *Illustrations.* 15*s. net.*

The present depression in world commerce not only points to the necessity of, but also presents an opportunity for, reconsidering the position of British interests, and for developing plans for the future. This is particularly the case in the Argentine, and in writing this book it was the late Mr. Koebel's purpose to describe present conditions and openings for trade there. Apart from historical bonds of friendship, in several important respects Great Britain has considerable advantages over her competitors in the Argentine. At present, for instance, 65 per cent. of the railways are controlled by British interests, and largely managed by Englishmen. Their reputation is such that, in other branches as well, American firms have employed English managers to a considerable extent. A large proportion of the trade of the Argentine is also carried on with Great Britain. Yet Mr. Koebel strongly emphasises the increasing foreign competition, especially German and American, that English firms must meet. The meat export trade, for example, though almost entirely for consumption in this country, is mainly controlled by American capital. For some time after the war American prestige in the Argentine had fallen, but by an intelligent study of the needs of the country, particularly by diplomatic and commercial missions, it has now been restored to a commanding position. One aspect of this is shown by the fact that the cable news service originates almost entirely in the United States, while she shares with Germany a monoply of the cinema film trade.

The Argentine, as the writer shows, is a country of great natural wealth still undeveloped, and it is surely worth an effort, on behalf of British commerce, to meet this rivalry methodically. Mr. Koebel's work, however, does not stress this aspect to the exclusion of all else. It deals with every side of the country's activities, and conveys an altogether attractive impression of the people and their surroundings.

AUSTRALASIA AND PACIFIC ISLANDS

Wanderings in the Queensland Bush.— W. Lavallin Puxley. George Allen & Unwin. 1923. Pp. 213. *Illustrations.* 10*s.* 6*d. net.*

Mr. W. Lavallin Puxley's solemn announcement that "the most typical animal of Australia is undoubtedly the kangaroo" might well cause apprehensions that he has brought back from his wanderings little more than a few weighty platitudes. Happily, however, he soon dispels such fears. He made but a brief sojourn in Queensland, and he does not profess to write with that special knowledge which only long residence in a country can give, but he is a naturalist with keen powers of observation, and he has many interesting things to relate, in a discursive manner, about the "Morning Land" which he has so obviously come to love. He sketches the exploits of the gallant little band of pioneers, many of whom gave their lives in the cause of exploration; he discourses upon dingoes, snakes, birds, the pestilential prickly pear, the platypus, and many another peculiar species which in this remote corner of the world has so far escaped extermination. He describes the various forms of agriculture—vanilla, sugar-cane, bananas, papaw, cotton, and citrus; he gives an account of a picnic to the beautiful Glasshouse Mountains, and presents a pleasant picture of station life, its freedom and open-handed hospitality; and, while discussing the chances of the settler, deplores the fate that is overtaking "the stone men," the aborigines, upon whom civilization has come too suddenly for long survival. He even touches (very gingerly) upon the thorny subject of local politics and the Queensland legislature, but while he admits that opinions differ widely as to the best means of securing the good of the community he declares that, so far as he has been able to ascertain, "upon one point all are agreed . . . that some day the state will rise to success."

On p. 75 there is a curious slip, when trees (instead of rivers) are made to "debouch into the sea." The book is well illustrated, but an index would have rendered it more useful, and it seems an extraordinary thing that a work of this type should be issued without a map of any description. Even those who have to travel by the fireside like to see where they are going. O. R.

HUMAN AND HISTORICAL GEOGRAPHY

Towns and Town Planning.— T. H. Hughes and **E. A. G. Lamborn.** Oxford: University Press. 1923. Pp. xii. + 156. *Price* 15*s. net.*

The scope of this work is well indicated by its very concise Table of Contents, viz. I. A Brief Historical Sketch, II. Town and Village in Britain, III. The Modern Movement, and IV. The Future. It is a brief but comprehensive account of systematic town planning in Western civilization, though most of the towns discussed in any detail are in this country. The second section is much the longest of the four, and to a geographer it is also the most interesting. As the authors state (p. 36), the street plans of the older central parts of English towns fall into two classes, one of which is well described as that of an irregular spider's web, with the main roads radiating from a small nuclear area, while the other shows a gridiron arrangement with two series of parallel streets. The former plan indicates that the town has grown without any definite plan or control; but towns of the second class must obviously have been formally laid out before building began. The great majority of our English towns belong to the first class—they have "just growed"—but investigation has revealed an unexpectedly large minority of planned towns or parts of towns. Among those referred to here Kingston-on-Hull (p. 68) and Oxford (p. 73) are of special interest. Although there is some difference of opinion as

to the size and importance of the settlement which occupied the site of Hull before A.D. 1293, there is ample historical evidence of the facts that Edward I. acquired the site and laid out the town. The older group of docks now occupy the area of his moat. The growth of Hull is essentially due to the advantage of its position at an angle of the Humber where the deep channel comes near to the shore at the mouth of a small river which gave safe harbourage for small vessels. No rival site had equal advantages, so that Hull was the natural successor to the trade of Ravenser. The credit due to the king is that of having taken advantage of the position. In the case of Oxford the evidence for the planning is entirely internal: it is sufficient to convince any student that Oxford began as a planned town, but it leaves us in doubt as to the date of its foundation. Many other old towns are discussed in part II., and well-known modern examples such as Bournville are described in part III. The last and shortest section makes no claim to originality, and all its contents will be familiar to any one in touch with the town-planning movement. Presumably it was added because writers on the subject are often expected to glance at future possibilities; but it is both irrelevant and inferior to the rest of the book. The volume as a whole is well written, in a clear and interesting style, and well illustrated. It should make a wide appeal both to the general reader and to the student. Its one serious defect for the latter is the lack of any bibliography or list of works consulted. Nor is there any systematic reference, by footnote or otherwise, to works which are quoted, so that it is not easy to follow up or check many of these references. There is an adequate index. C. B. F.

Bering's Voyages.— **Prof. F. A. Golder.** Vol. 1. New York: American Geographical Society. 1922. Pp. x. and 372.

This work forms part of the excellent "Research Series" of volumes now being issued by the American Geographical Society. It deals with the two voyages of exploration made by Vitus Bering in the sea which bears his name, and is based upon the logs kept by the ships of the expeditions and the reports of the naval officers who served under and survived him. Vol. 2, which has not yet been issued, is to contain the journal of G. W. Steller, the talented and ill-fated naturalist who accompanied the second expedition.

Owing to the fact that the official accounts of Bering's voyages were published only in the Russian language, geographers of other nations have, in general, been compelled to rely upon the accounts given, at second-hand, by such authorities as Müller, Pallas, and Coxe, while a large amount of first-hand information has remained hitherto in MSS. in the Russian official archives, and has hence been inaccessible to the student. It has, accordingly, been difficult to arrive at a precise estimate of Bering's work, although the extent of his explorations and discoveries has, of course, long been a matter of common knowledge. Thanks, however, to the labours of Prof. Golder, who has made an exhaustive personal examination (completed, fortunately, just before the Russian revolution) of all available material, geographers have now been placed in possession of a mass of information sufficient to satisfy the most exacting, and comprising practically all the documentary evidence known to exist.

After a preliminary chapter giving a sketch of the geographical knowledge of North-eastern Asia at the beginning of the eighteenth century, Prof. Golder gives in full the instructions issued to Bering for his first voyage, and the report made by him on his return, illustrated with a facsimile of the map accompanying the report (the names, however, transliterated into Swedish), and

also a facsimile of Berkh's map of 1823, on which Bering's route is shown corrected in the light of modern cartography. It was in this voyage that the explorer discovered and traversed the strait named after him, although he turned back, for no very obvious reason, without definitely establishing the non-existence of any land connection, further northward, between Asia and America.

A short account is also given of Gvozdev's voyage of 1732, which forestalled, to some extent, Bering's second voyage, since Gvozdev undoubtedly sighted the north-west coast of America, although he did not identify it at the time.

After recounting the circumstances attending the preparations for the second expedition, Prof. Golder prints, *in extenso*, the log of Bering's ship, the *St. Peter*, and also that of her successor, of the same name, built at Bering Island after the leader's death. He also gives two reports made by Chirikov, who commanded Bering's consort, the *St. Paul*, which contain an account of his proceedings after parting company with the *St. Peter*, including the most dramatic and mysterious event of the whole voyage—the successive and total disappearance of two fully-armed boats and crews sent to explore the American coast in the vicinity of Cape Ommaney.

The valuable information contained in these logs and reports is supplemented by a most interesting chart compiled by the late Captain E. P. Bertholf, of the U.S. Coast Guard, showing the tracks of the two vessels plotted on a modern chart of the North Pacific. A memoir, also by Captain Bertholf, which accompanies the chart, discusses the navigation of the voyage, and the exact locations of the landfalls made on the American coast.

Prof. Golder has spared no pains to render his book as complete as possible, and the very numerous footnotes attest the scholarly and thorough character of his labours. He appends a very complete bibliography of the subject, including both printed and MS. authorities. The illustrations comprise, in addition to the charts already noted, reproductions of various MS. maps in the Russian archives and facsimiles of selected pages from the logs. R. T. G.

GENERAL

Charles de Foucauld, Hermit and Explorer.— René Bazin. Translated by **Peter Keelan.** London: Burns, Oates, & Washbourne, Ltd. 1923. Pp. viii. and 356. 12*s.* 6*d.*

It is regrettable that so valuable a contribution to the geography and penetration of North Africa as Bazin's 'Life of Charles de Foucauld' should have been produced without either map or index. The absence of any system of transliteration of names and the recurrence of Gallicisms, as "a religious" for a servant of the Church, are equally unfortunate, but with all this a service has been rendered in making the story of this man's life accessible to English readers. The idealism and romance, that savour more of the Middle Ages than of this century, of a gay, wealthy but extravagant member of an old aristocratic French family, who after accomplishing one of the most remarkable early reconnaissances of the then closed land of Morocco, retired from the world to become a Trappist Father and finally a hermit priest among the Tuareg, combine to form the picture of personality at once so vivid and so human, that the reader will inevitably tend to forget the contributions which Father de Foucauld made to science. His journey through Morocco disguised as a Jew is summarized in the report presented to the Paris Geographical Society by Duveyrier when he announced that de Foucauld had been awarded the Gold Medal for his work: "In eleven months from June 1883 to May 1884 the Vicomte de Foucauld has doubled the length of the carefully surveyed

itineraries in Morocco. He went over again and perfected 689 km. of the work of his predecessors, and added 2250 km. to them. As to astronomical geography he has determined 45 longitudes and 40 latitudes, and where we only possessed a few dozen altitudes he has brought back 3000." All this de Foucauld accomplished in close disguise and at the risk of his life. This journey was followed by another in southern Algeria and Tunisia, but already when he returned from Morocco he had written that every one in Africa, Jews and Moslems alike, seemed to worship God, except the Christians.

He left the army and became a Trappist monk, but the Rules in none of the monasteries he visited in Syria, France, or Algeria seemed hard enough for his humility and devotion. He was eventually ordained priest, and established himself in a retreat at Beni Abbes, from where he came to be known to all the natives in southern Algeria. But that spirit which can be felt and never defined had touched him, and he was to move yet further afield. In 1904 he accompanied the great Saharan commander, Laperrine, his own brother officer of St. Cyr, on the memorable reconnaissance to the Tuareg country in the Ahaggar mountains which led to the pacification of this division of the people. Here he eventually settled to teach the People of the Veil by his example and by his own life to achieve the Truth which the spirit of Africa taught him. During the twelve years he lived at Tamanghasset, preaching by his example, or learning the language and lore of the Veiled People, he made no convert to Christianity. It is all the more regrettable that the author of his biography should have deemed it necessary to digress into an exordium on the desirability of encouraging the conversion of Moslems to Christianity.

Father de Foucauld lives after his death among the people of the desert as the Great White Man of God. His dictionary of the Ahaggar dialect of the Tuareg language is our standard work; his knowledge of the people, embodied in notes which his modesty forbade him to publish in the form of a book, was immense.

He was killed in 1916, during a raid by Tuareg and Arabs from without his own country, from Ghat in the Fezzan, who had been sent by the intrigues of the Senussia to capture the man that was most respected and feared at a time when they hoped to raise the Ahaggar Tuareg against the French. That they did not, is in great part due to Father de Foucauld. His monument stands with that of his friend Laperrine in the Fort of Tamanghasset, which the officers of the post would have called Fort de Foucauld, had not Laperrine pointed out before his own death in flying to Timbuctoo how much grief this publicity would have caused to the humble priest. The picture of the Tuareg contained in the latter part of the volume is essential to the student of this people, as the whole work is a commentary on the penetration of the Sahara. F. R.

THE MONTHLY RECORD

EUROPE

Alleged Deterioration of the New Forest.

A NOTE in a recent number of the *Journal* on the preservation of beauty spots has induced a correspondent, Mr. Lowther Bridger, to draw our attention to the present condition of the "People's part" of the New Forest. He asserts that for lack of proper forestry it is rapidly deteriorating as a beauty spot. Nothing is being done to arrest the decay of the woods of oak and beech, or to replace the fallen trees. The state of Mark Ash, in particular, is cited as an

example of the extent to which age and weather have ravaged the Forest. There is, apparently, no body charged with the care of the Forest as a whole. Two-thirds of the Forest is Crown property, and the Department of Woods and Forests has confined its attention, as regards forestry and replanting, to the Crown enclosures. Recently, to relieve local unemployment, the Treasury sanctioned expenditure upon the draining of certain areas. Except for this, nothing has been done for the preservation of the open forest, which is said to be degenerating into a jungle of scrub and wild holly. Mr. Lowther Bridger has attempted, so far in vain, to get the question taken up by some public body, such as the National Trust. The general impression is that the whole Forest is under the Department of Woods and Forests and is being adequately cared for. The local residents consider its upkeep to be a national duty entirely. It is hoped by means of a question in Parliament to obtain a definite statement upon the subject.

The Marine Deposits of the Southern North Sea.

A remarkable addition to our knowledge of these deposits has resulted from the researches carried out during cruises of the Marine Biological Association's S.S. *Huxley* and (to a much smaller extent) those of the same Association's S.S. *Oithona*. The results are described in a most interesting publication of the Ministry of Agriculture and Fisheries by Mr. J. O. Borley, Principal Naturalist on the staff of that Ministry (Fishery Investigations, Series II, Sea Fisheries, vol. 4, No. 6). The investigations were carried out primarily from a biological standpoint, since the character of the deposits on the sea-bottom is naturally of great importance in determining the distribution and abundance of the species living in or upon the sea-bed or in its vicinity; but the facts brought out are of interest, too, from the point of view of physical geography and geology as well as hydrology. The area over which samples were collected is nearly 68,000 square miles, mainly south of 56°, whilst the greatest attention was paid to the southern and western parts of the area. Owing to their terrigenous character the deposits vary much more rapidly from place to place than is commonly the case with oceanic deposits, and as the last submergence took place quite recently in a geological sense, old land surfaces contribute materially to the present constitution of the sea-bed. Results obtained by the usual method of the sounding-lead armed with tallow give little help towards a detailed knowledge of the deposits, and, closing leads too proving unsatisfactory, they were abandoned in favour of the conical dredge, which proved thoroughly efficient, raising as much as three buckets full at a time, and supplying evidently characteristic samples. The extent of sampling varied in different parts of the area, being greatest in the southern bight, where the frequency in parts of the English area reached one in 50 square miles. As this is known to be very patchy, while the ground east of the Dogger is generally uniform, the greater frequency in the former was in every way suitable. The material collected was divided into ten grades, and the distribution of each over the area is shown in a series of charts according to their percentages of the whole deposit for each locality. The coarser grades (down to fine gravel) occur along the English coast, and the next in order (coarse sand) has the same distribution, though with a tendency to exceed the gravel boundaries. Medium sand, making up nearly half the material of the southern bight, is most abundant in a belt fringing the previous groups, while fine sand, though generally predominant, is most abundant north-east of the medium sand, and silt is associated with estuaries, or relatively stagnant portions of the sea. The material is also

divided into types according to its constitution and colour, and the distribution of these is discussed. In a final section dealing with the causes of the distribution the conclusion is reached that this is largely the effect of selective transport by current aided by wave action, the accumulation of fine material over the English rough area being checked by the rapid motion, whilst there is a regular grading of material from the Strait of Dover to the ground east of the Dogger.

Rainfall in the High Mountains of Sweden.

A lengthy discussion in French by Axel Wallén of a new map of rainfall distribution in the mountainous part of Norrland appears in the *Geografiska Annaler*, Häft 1, 1923, The accuracy of earlier maps of the region had been questioned on account of the inevitable paucity of rain-gauges in high thinly peopled areas. But in 1908 the Hydrographic Bureau, in collaboration with the Meteorological Institute, established a large number of new pluviometric and limnimetric stations in the upper portions of twenty-eight of the river and lake basins of Norrland draining into the Baltic. A careful study was made of the relationship between rainfall, evaporation, and discharge, and the knowledge acquired was used to extend the information yielded directly by the rainfall stations. The new map, based on the decade 1911–1920, shows that the rainfall in the mountains is heavier than was formerly represented. The three primary factors governing its distribution in the Swedish highlands are proximity to the Norwegian coast, altitude, and configuration. Broadly speaking, the isohyets run parallel with the Norwegian frontier, but they bend eastward into all those upland river-basins into which the westerly winds find access through gaps in the mountain rampart. The increase of rainfall with altitude is also found to be much greater in those localities exposed to the westerly winds than in those which are sheltered therefrom, a conclusion in accord with the general theory of orographic rainfall accepted in this country. Near the Norwegian frontier the mean annual fall everywhere from north to south exceeds 40 inches, and in many of the upland basins where the configuration is favourable it exceeds 60. The wettest basins are those of the Indal and Fax in the south, and of the Kalix and Stora Lule in the north, in the latter of which the amount reaches 50 inches. On the other hand basins well sheltered by the high mountains of Norway, such as the Torne, Lilla Lule, Pite, Skelleft, Ljungan and Ljusnan, are much drier. On the highest summits the annual fall is considered to surpass 120 inches (3000 mm.). A full comparison on the same basis with the neighbouring part of Norway with its great mountains and snowfields, such as the Svartisen, would have been instructive, and one must deplore once more the common practice of stopping short at political boundaries when representing meteorological data.

ASIA

Hydrographical Investigations at Lake Tamblegam, Ceylon.

Dr. J. Pearson contributes to the *Bulletins of the Ceylon Fisheries*, vol. 1, 1–3, 1922, the results of investigations into the specific gravity of the water of Lake Tamblegam in connection with the window-pane oyster fishery. The lake is a landlocked backwater connected with Trincomalee outer harbour, with an area of about 6 square miles and a depth of 5–8 feet. Every month since September 1915 samples have been taken from eight stations in the lake. The wet cool season is from November to January ; consequently a very low degree of salinity obtains during December, and a high degree during June. The centre of highest salinity moves from the entrance of the Lake in December along the northern shores until it reaches the head of the lake in June, after

which it moves back to the entrance. Similarly the centre of lowest salinity moves along the southern shores. Most noticeable is the suddenness of the change in salinity in the months of November and December. At the beginning of January the water in the lake is practically fresh ; this determines the breeding season of the window-pane oyster, which spawns about the end of the month.

AFRICA

The Fishing Industry of the Ivory Coast.

An interesting short sketch of the fishing industry as carried on by the natives of the Ivory Coast is given in *La Géographie* (Sept.–Oct. 1923) by M. H. N. de Fleury. The native inhabitants restrict their operations mainly to the lagoons with which the Ivory Coast is fringed, sea-fishing being in less favour by reason of the dangerous bars to be crossed in order to reach the open sea. It is practised mainly by strangers from the Gold Coast, numbering perhaps not more than one hundred, but well equipped and skilful. Both the sea and lagoon fishing are carried on throughout most of the year, the latter being interfered with only at the height of the rains. The lagoons are extremely well stocked, and the fish is exported in great quantities both to the interior parts of the Ivory Coast and to the Gold Coast. For the sea fishing vessels up to 5 or 6 tons, with a crew of six to ten men, are employed, and two kinds of nets (according to the size of the fish) are used, as well as lines with hooks. The lagoon fishing is carried on in canoes with one or two men in each, and besides the more ordinary appliances, a method much in favour is the blocking of channels by barriers of reeds or mats so arranged that the fish are trapped in a compartment with no easy outlet, from which they are taken by a diver with a hand net. Most of the fish are of similar kinds to those found in Europe, and they are eaten either fresh or smoked, those destined for transport inland being of course smoked. The daily catch for one canoe may amount to 100 or 150 kilogrammes.

AMERICA

Resources of Central Canada.

From the Natural Resources Intelligence Branch, Ottawa, we have received a mimeographed pamphlet, 'The Hudson Bay Railway Belt and Hudson Bay,' dealing in detail with the resources of an area of 70,000 square miles lying in Manitoba, roughly bounded by the Pasquia Hills, Hudson Bay, Hayes River, and Churchill River. Physically, it is a low undulating region, sloping gently to the swampy shores of the bay. It is much cut up by lakes and rivers, of which the chief are the Hayes, Nelson, and Churchill rivers, 15 to 20 per cent. of the whole area being water surface. The Hayes River is navigable for 140 miles from its estuary at high water, and the Nelson for 60 miles from Lake Winnipeg and about the same distance from its mouth. The Saskatchewan River, between Lakes Cumberland and Cedar, is navigable for steamers and is the main east-and-west route. A branch of the Canadian National Railway runs from the Winnipeg–Prince Albert line to the Pas, whence a line has been built down the Nelson River to within 92 miles of Port Nelson on Hudson Bay. Up to the present this region has not been greatly developed, chiefly owing to lack of communications. There exists, however, a central belt between the Churchill and Nelson rivers, of approximately 10,000 square miles, most of which, with little trouble, could be made available for mixed farming. Wheat and barley have been grown successfully between latitudes 54° and 55°. With the facilities offered by Port Nelson for reaching the English market, it is thought that a profitable stock and breeding industry could

be established in the neighbourhood. The greater part is predominantly a spruce and pine region ; with proper drainage and attention, the establishment of a pulp industry should be possible. Lumbering has already been started at the Pas. This town is in the centre of a mineral belt 125 miles in length and 30 wide, from which gold, silver, and copper have been obtained in small but workable quantities. The development of the great potential water-power of the region should help to overcome difficulties in smelting and promote the paper and pulp enterprises. Other resources include the fisheries in the lakes and the bay, from which salmon, sturgeon, and whitefish are obtained, and the fur trade, the annual output of which, passing through the Pas alone, is estimated at one million dollars. It is also hoped that the completion of the Port Nelson railway and harbour scheme will attract much of the traffic between the Far West and England.

Explorations in the Basin of Lake Maracaibo.

Although Lake Maracaibo, with its well-known pile-dwellings (still persisting to the present day), was one of the first parts of the South American coast to be visited by the early Spanish voyagers, the country round it is still but imperfectly known to science. Some useful additions to our knowledge of the country and its vegetation have been made by the well-known botanist, Prof. H. Pittier, in the capacity of Naturalist on the Venezuelan side on the recent Venezuela–Colombia boundary Commission. He has published the preliminary results of his studies in a brochure published last year at Caracas. Prof. Pittier found on arrival that the extremely unfavourable weather conditions in the districts to be visited by the Commission were likely to make botanical research impossible, and therefore filled the time instead with various excursions inland from the shores of the lake, both west and east. He gives a clear account of the climate and physical conditions as they vary from the arid *régime* of the sandy tracts near the coast-line through an intermediate belt of savannahs to the more fertile country on the Rio Palmar and its upper branches, covered in part by a true monsoon forest. The vegetation of each zone is brought into relation with the natural conditions, and the commercial possibilities in the way of timber and other products are touched upon. Much of the country is a nearly level plain across which the rivers flow in wide curves, with the natural tendency to desert the most pronounced loops so as to take a more direct course. A special feature is the network of muddy channels separated by mounds, known as *tatucos*, whence the whole complex is named a *tatucal*. Dr. Pittier ascribes its origin to very gradual erosion. The more active erosion of the river-banks tends to destroy the high woods, and the abandoned loops are first invaded by an impenetrable jungle of the light-loving *Inga*, which is specially characteristic of the Lora branch of the Palmar. In course of time the higher trees gain ground, so that there is a complete cycle leading back to the high forest. In this three species of tree dominate all the rest: the classical *ceiba* or cotton-tree, the *cabima*, and the *bacu*. The first is not exploited here, as elsewhere, for the supply of vegetable wool. The second is a *Copaifera* (yielding copaiba balsam), but Dr. Pittier was surprised to find that it does not belong to the common species, and that the superiority of the Maracaibo product to that of Cuidad Bolivar may be due to this specific difference. The bacu is a species of *Cariniana*, very near that which produces the "Colombian mahogany." Among the Lauraceæ is a species commonly known as *toda-especia* ("allspice") which is remarkable for the occurrence of the essential oil (valuable in medicine) in a cavity in the heart of the tree. The region as a whole does not promise much in the way of agriculture.

The latter part of the paper describes a journey to the east of the lake, through a district in which petroleum is being actively exploited by various companies, the chief centre being at Mene Grande, connected with its port of San Lorenzo by a light railway. Dr. Pittier was witness of the sudden outburst of a " gusher " from one of the borings, by which a large amount of oil was lost, finding its way to the lake in a regular river. Here, too, he describes the vegetation features, which differ somewhat from those to the west of the lake, in considerable detail. A classified list of the principal trees and other plants of the region is given as an appendix.

AUSTRALASIA AND PACIFIC ISLANDS

Pan-Pacific Congress.

The second Pan-Pacific Congress was held in August 1923 in Melbourne and Sydney. Over one hundred and thirty delegates attended, among them being representatives of Great Britain, the United States, Canada, New Zealand, Japan, and the Netherlands. The two objects of the Congress were the discussion and initiation of concerted action in all scientific problems connected with the welfare of the peoples of the Pacific, and the strengthening of the bonds of peace by the maintenance of harmonious relations. The arrangements for this session were made by the National Research Council of Australia. The British Government was represented by Dr. E. J. Butler, Sir Gerald Lenox Conyngham, Mr. H. F. Marriott, and Dr. G. A. K. Marshall, and this Society by Sir Douglas Mawson. The trend of discussion may be judged from the proposals submitted by the sections and approved by the general meeting. Much emphasis was laid upon the need for anthropological research, especially in the region of New Guinea, where the Mandatory Powers had incurred great responsibilities. The practical value of the science in administrative and welfare work was urged, and the example of the appointment of two Government anthropologists in Papua commended. Warnings were entered by the Forestry Section against a general shortage of coniferous woods, and the Commonwealth Government was requested to meet this by the development of research through a Forestry Products Laboratory, and by the formation of timber reserves. The Geodetic and Geographical Section expressed regret at the suspension of the geodetic survey of New South Wales, recommended the undertaking of a similar survey for all Australia, and urged the publication by the several governments of the sheets of the International 1/Million map for which they are responsible. In the Geological Section, likewise, the importance of accurate topographical and geological maps for the development of mineral resources was pressed. For the co-ordination of work in this direction by the various Australian States, the creation of a Federal Geological Survey was suggested. It was also hoped that the work of the Government geologist in Papua would receive further support, and like work extended to Fiji to investigate problems connected with coral reefs, earth-movements, and mineral resources. The enlargement of the meteorological and seismological observatory at Samoa was also advocated. The section endorsed the general plans of the committee appointed to deal with the problems of the Great Barrier Reef. Recommendations by the remaining sections included the appointment of a committee to investigate the temperature, salinity, currents, etc. of the Pacific, and to provide for the co-ordination of work already accomplished, the radiation of a daily mean time signal from various centres, and of a scientific time signal from Honolulu. Before the close of the session the invitation of Japan to hold

the next meeting in Japan in 1926 was accepted, and steps were taken to establish a permanent organization of bodies engaged in Pacific research.

POLAR REGIONS

The Canadian Arctic in 1923.

We have received from Captain H. T. Munn, who once more visited the Davis Straits–Baffin Bay region in 1923, the following notes on ice conditions in the straits last summer, and other matters of interest. The ice observations were made between September 3 and 26.

From Port Burwell on the south side of Hudson Straits, where the Hudson Bay Co. S.S. *Nascopie* picked him up, to Cumberland Gulf and thence to Clyde River and Ponds Inlet (Eclipse Sound) he saw no field ice of any kind. In ten voyages in these waters he has not known them so free from ice. The Eskimo at Ponds Inlet told him the ice left the inlet in the first week in July, a month earlier than usual. Cumberland Gulf was also clear of ice unusually early. The fur catch for the winter of 1922–1923 for Baffin's Land was a fairly good one, about 3000 white fox being the total for Cumberland Gulf and Ponds Inlet combined. Whales (*Balena mysticetus*) were reported in greater numbers than for some years past off Ponds Inlet, and narwhal were also numerous there and in Eclipse Sound.

Royal-Canadian Mounted Police posts are now permanently established on Ellesmere Land, Ponds Inlet (Eclipse Sound), and Cumberland Gulf, and other posts are to be established this year, probably west along Lancaster Straits and at Lake Harbour on the north side of Hudson Straits; the whole of the Canadian Arctic, from the 141st parallel eastward to the shores of Ellesmere Land and Baffin's Land, may therefore be said to be under effective occupation and administration. This will probably encourage small share-owned and manned auxiliary schooners to winter in favourable places, which will develop the oil industry and other resources of Stefansson's "Friendly Arctic."

A court was held at Ponds Inlet this summer, and three Eskimo concerned in the murder of a white man in 1919 received varying sentences of imprisonment. This is the most northerly civil court ever held under the British flag.

The Loss of the "Karluk."

The recent publication in a London paper of a photograph of the *Karluk's* crew, in reference to the more recent disaster to the Wrangel Island party, has brought to light a small piece of history which to avoid future confusion should be put on record. Among the *Karluk's* men lost on the attempt to reach Herald Island was one borne on the ship's books as A. King. It is now established that he was really Edmund Golightly, son of Colonel R. E. Golightly, who, having strong ambition to Arctic adventure, exchanged name and papers with King, and bears his name in all the official records of the Stefansson expedition.

MATHEMATICAL AND PHYSICAL GEOGRAPHY

Physical History of the North Atlantic.

A striking sketch of the past history of the North Atlantic and of the influence which that history has had on present conditions is given in *La Géographie* (September–October 1923) by MM. Germain, Joubin, and Danois, writing in conjunction. No attempt is made to go back to the early geologic epochs, but the story is taken up at the beginning of the Tertiary period, when (during the Eocene) the North Atlantic was represented by a comparatively narrow

belt of water forming a " Mediterranean " sea, stretching from Florida to the Bay of Biscay and communicating with the Mediterranean (as we know it) by branches crossing southern France and eastern Spain. To the north was a vast North Atlantic continent, one of the oldest land-masses of the Northern Hemisphere, brought into being by early folding movements; to the south the Continent of Atlantis, bounded by water on the south also in a line running from Central America to Cape Verde. In course of time the Northern continent sank beneath the water, the movement being most pronounced between Greenland and Scandinavia. The Atlantis may have persisted in a somewhat reduced form to the end of the Miocene, occupying the site of what is now the Sargasso Sea, and separated both from America and from Europe and Africa. In this way the Mediterranean proper communicated with tropical waters by the strait south of the Rif, whilst its connection with the colder northern waters was interrupted. In Pleistocene times Atlantis became a mere string of islands, and the final catastrophe may possibly have been the origin of the well-known story of Plato. The Cassiterides of the early writers may have persisted near Cape Finisterre down to the same period. This theoretical history can be supported by many faunistic proofs, to a consideration of which the latter part of the paper is devoted. The Atlantic groups show a distinctly continental character, with many mutual affinities in spite of the fair number of endemic species in each. The most characteristic genera of molluscs are survivors from the Tertiary epoch, when similar forms occurred in Western and Mediterranean Europe. And other groups supply similar evidence, bringing out the remarkable community of forms between Central America, the Antilles, the Atlantic islands, and the Mediterranean basin. The Sargasso Sea furnishes a strong argument both in its fauna and flora. The former is essentially littoral and yet has no immediate affinities with the forms of either the American or the European coasts. The seaweed too is of a special form and is to be regarded as the survival from the coastal fringe of the old Atlantis. But the most striking evidence of all is that supplied by the life-history of the eel as revealed by the researches of Dr. J. Schmidt and others. The regular migration of the eels both of Europe and North America to this part of the Atlantic for breeding purposes, and eventually to die, is held to be a remarkable instance of ancestral memory, the present-day forms being the descendants of the Tertiary eels which peopled the waters of the north-west coast of the old Atlantis. The present-day circulation of the North Atlantic may also be considered a direct result of the past history of the region.

GENERAL

The Imperial Institute and the Industries of the British Empire.

The *Bulletin of the Imperial Institute*, vol. **21**, No. 1 (London: John Murray, 1923), consists of a very full and interesting " Report on the Operations of the Imperial Institute," particularly in the initiation and development of industries within the British Empire—a subject at present much to the fore. This aspect of its work has been growing of recent years, having received considerable impetus from the necessity of meeting the situation created by the war, though the Scientific and Technical Department dates from 1896. The function of this section, which is assisted by the Technical Information Bureau and various Technical Advisory Committees, is to supply information and advice on the requirements of the home markets, and the possibility of developing alternative sources of raw material within the Empire as well as upon the technical details of standards and processes, and to encourage as far

as possible the establishment of industries where conditions are found to be favourable. The Technical Committees, especially the Raw Materials Committee, form the necessary link between the Institute and the business community. In 1922, the total number of reports furnished by the department on investigations and inquiries was 1334, of which 265 were official. Its publications, which, besides the *Bulletin*, include the Monographs on Mineral Resources and Handbooks to the Commercial Resources of the Tropics, serve to make the information thus acquired accessible generally. Particular attention has been devoted to the development of the Empire's timber resources and to the production of materials for paper-making, in which connection the bamboos of Kenya and the grasses of Nigeria have been found suitable. Amongst other useful work done has been the utilization of the deposits of monazite sand in Ceylon for gas-mantles, the encouragement of cotton-growing in Mesopotamia and Tanganyika territory, and of tobacco-growing in Nyasaland, and the development of the Gold Coast cocoa trade. The value of this work is now widely appreciated both at home and abroad. Some mention must also be made of the educational value of the exhibition galleries housed in the Institute.

OBITUARY

Brigadier-General George Pereira, C.B., C.M.G., D.S.O.

ONLY a few months ago we had announced the accomplishment by General Pereira of a remarkable journey from Peking across North-Eastern Tibet to Lhasa and thence to India. And now we have to record the death (from gastric ulcer), at Kangse on the Chinese frontier, of the daring and indefatigable traveller. General Pereira had for years past travelled in unknown and little-frequented parts of the Chinese Empire, and his travels were all the more remarkable because since he was a young man he had suffered from grave physical disabilities due to a fall from a horse. Possessed of an indomitable spirit, he indulged alternately his passion for racing and his passion for travel. He was not a highly trained geographer in the technical sense. But he was a born traveller. He travelled from sheer love of travel. And he was a man. He knew human nature and he could be both determined and considerate. Consequently, he could make his way through a hostile people and be of high service to geography by leaving a favourable impression behind wherever he went, and by so doing make the way easier for all future travellers.

He was regarded with peculiar affection by his brother officers in the Grenadier Guards. And a like affection he won from his countrymen in China and from the Chinese with whom he was brought in contact.

The results of his great journey he had not put into shape before his death. He had kept notes and had intended to write a book on his return. But instead of returning directly to England from Tibet he had made his way again into China and there met his end. So of his splendid achievement we shall never have a worthy account.

General Pereira was born in 1865 and educated at the Oratory School, Edgbaston. After fifteen years of home service with the Grenadier Guards he was sent to China on special service, was wounded during the operations there in 1900, and afterwards saw more active service in South Africa. He was military attaché at Peking from 1905 to 1910; served in the Great War; and

about three years ago returned to his travels in China. A brief notice of the journey to Lhasa was published in the *Journal* for February 1923.

F. E. Y.

Brigadier-General A. C. Bailward.

We very much regret to record the death of Brigadier-General A. C. Bailward, who had been for seventeen years a Fellow of the Society and a regular attendant at its meetings, but who, although he was a constant traveller with a wide knowledge of the Middle East, had published little or nothing, and was so little communicative either of his plans or of their outcome that it was only incidentally one learned of his journeys. One fears therefore that his great knowledge and experience are irrevocably lost unless it should prove on examination of his papers that he has left manuscripts sufficiently prepared for publication. General Bailward entered the Royal Artillery in 1874 and retired from it in 1905. He must therefore have been older than he looked, but the usual sources of information are silent, and we can tell of him only that he was a widely travelled, but uncommunicative and most retiring soldier, beloved of his circle of friends.

MEETINGS: ROYAL GEOGRAPHICAL SOCIETY: SESSION 1923–1924

Third Evening Meeting, 3 December 1923. The President in the Chair.

ELECTIONS.—Dr. R. S. Allan; Major H. G. Brackley, R.A.F.; Gordon Cartwright; Miss Nora Margery Cobb, B.A.; Walter Frederick Creevy; William P. Draper; Thomas Addis Emmet; Hugh Hubbard Ford: Edmund William Gilbert, B.A.; John A. Haeseler, B.S.; Dr. Edward Hicks Hume, A.B., A.M.; Kenneth William Johnstone; James Nason-Jones; Gilbert A. Last; Mrs. Margaret Lloyd; Robert Hunt Lyman; Major Ernest Ronald Macpherson, R.A.O.C.; Miss Dorothy Vaughan Morgan; Mrs. Hilda Winifred Musselwhite; R. Parr, B.A.; W. G. Scoon; Lieut. Joseph Russell Stenhouse, D.S.O., D.SC., R.N.R.; Frederick Stratford; Frank Craymer Toogood.

PAPER: A Year in Lhasa. Sir Charles Bell.

Second Afternoon Meeting, 10 December 1923.—The President in the Chair.

The Work of the Liverpool Tidal Institute. Dr. A. T. Doodson.

Fourth Evening Meeting, 17 December 1923.—The President in the Chair.

ELECTIONS.—James Ernest Arnold; Ewen Norman Hay Cameron; Hugh Meadows Clutterbuck; Walter Cunningham, J.P.; Comte Byron Khun de Prorok; Capt. Belford Kinchant Featherstone, I.A. (Retd.); William Owen Fielding-Jones; Capt. Douglas Hamilton Gillette (U.S. Army); Ansfride de Cormeille Grove; Floyd Alonzo McClure, B.A., B.S.; Col. Harry McMicking, C.B., D.S.O.; Rev. Tom Mortimer, B.A.; Herman Cameron Norman, C.E., C.S.I., C.B.E.; Major Edward Felix Norton, D.S.O., M.C., R.F.A.; John Patrick Robinson; Douglas Hector Smith, B.SC.; Raymond Harry Sproat, M.A.; Prof. Henry S. Townsend; Sir Charles Walston, LITT.D., PH.D.; Major F. V. B. Witts, C.B.E., D.S.O., M.C., R.E.

PAPER: The Influence of Nature on Japanese Character. Rev. Walter Weston.